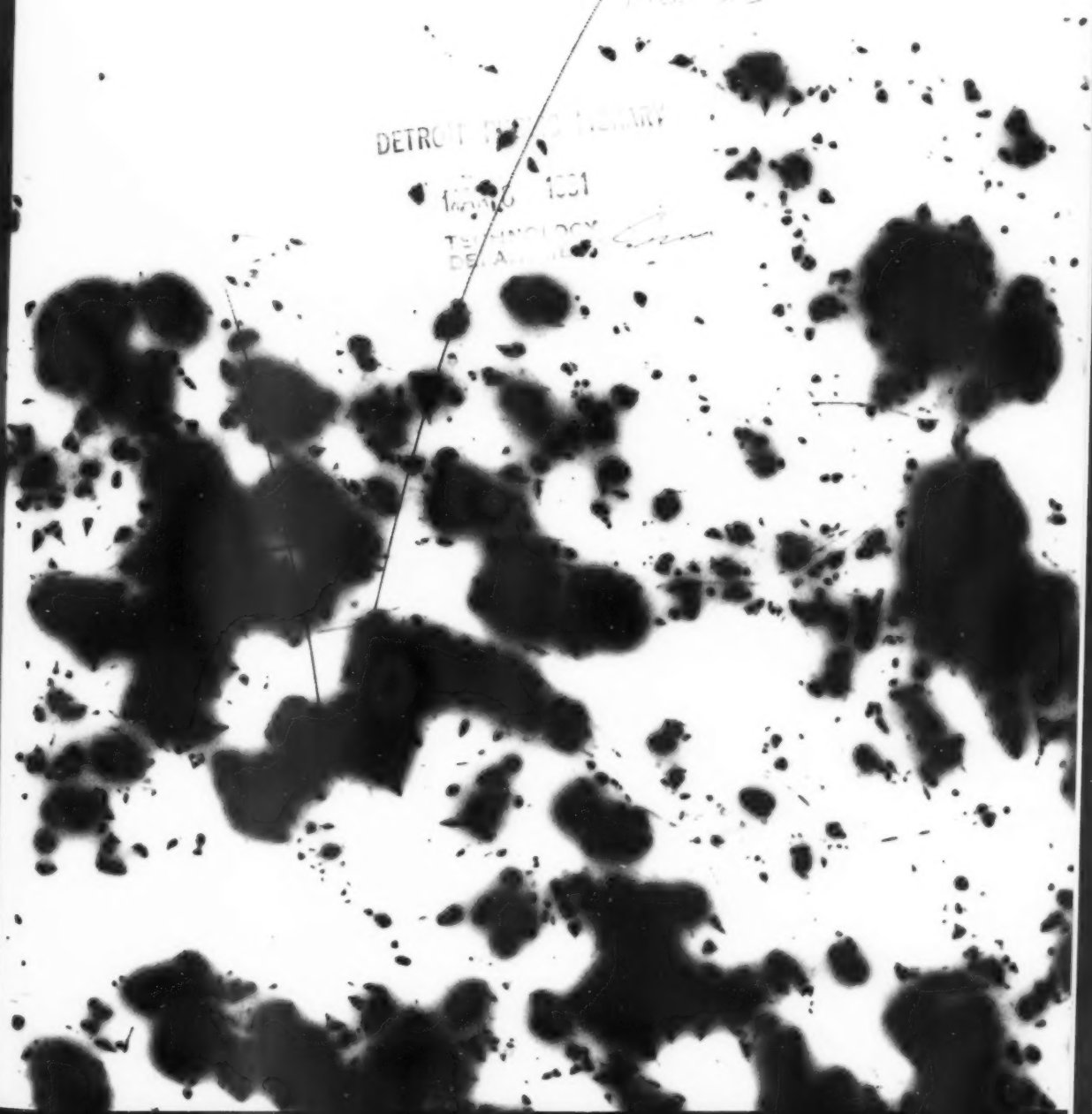
Technology Review

March, 1961: A Timely Report on Arms Control, Page 15



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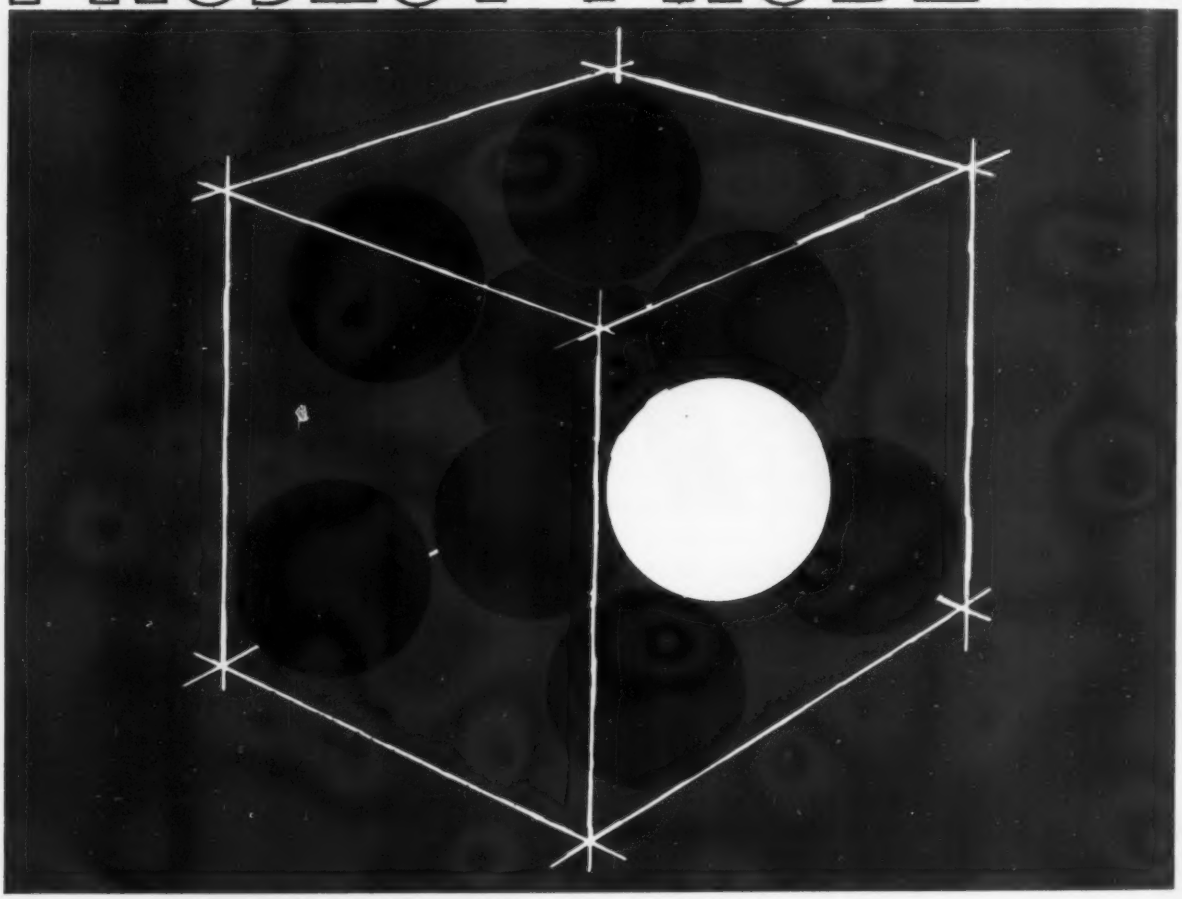

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Technology Review

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Volume 63, Number 5 *Edited at the Massachusetts Institute of Technology* *March, 1961*

Feedback

The Perils of Writing

IN A widely quoted article that appeared last year in both Cal Tech's *Engineering and Science* and The Technology Review, Richard P. Feynman, '39, announced his "intention" to offer $1,000 to the first man to make a "rotating electric motor which can be controlled from the outside and, not counting the lead-in wires, is only 1/64th inch cubed." Well, somebody did it.

William McLellan of Pasadena, Calif., built such a motor with the help of a microscope, a watchmaker's lathe, and a toothpick. It weighed 250 micrograms and had 13 parts.

Although Professor Feynman never had really posted a prize, his conscience bothered him so much after he had seen McLellan's motor that he "sent the guy a check for a thousand bucks." Feynman also suggested another prize (see Technology Review, May, 1960, p. 46), but says he can't spare another $1,000 right now.

Professor Feynman teaches physics at the California Institute of Technology and will be one of the participants in the M.I.T. Centennial observance next month (see page 12).

Research Corporation's Role

FROM J. W. BARKER, '16:

The extremely interesting and well-written article "Van de Graaff Electrostatic Generators" by our old friend Jim Rowlands appeared in Technology Review, January, 1961. It has, however, one large omission of fact.

Karl Compton presented to Research Corporation a request for a grant to Van de Graaff (then at Princeton but shortly to move to M.I.T.) for the research precedent to and the construction of his electrostatic generator. This grant was made by the Board of Research Corporation and also a large portion of the "Round Hill Machine" was machined in the Research Corporation plant at Bound Brook, N.J. There is no mention in Jim's article of Research Corporation's early support of Van de Graaff's original work. This is a bit surprising since Jim later mentions the "Godfrey M. Hyams Trust" as making a grant for the Massachusetts General Hospital unit.

420 Lexington Avenue
New York 17, N.Y.

FOR SCOOTER RIDERS at M.I.T. this was the roughest winter since their vehicles became popular. The January cold spell in Boston was the longest in many years.

EDITOR: Volta Torrey; BUSINESS MANAGER: R. T. Jope, '28; CIRCULATION MANAGER: D. P. Severance, '38; EDITORIAL ASSOCIATES: J. J. Rowlands, Francis E. Wylie, John I. Mattill; EDITORIAL STAFF: Ruth King, Muriel R. Roberts, Pauline Gates; BUSINESS STAFF: Madeline R. McCormick, Marianne G. Hagerty; PUBLISHER: H. E. Lobdell, '17.

The Technology Review is published monthly from November to July inclusive, on the 27th day of the month preceding the date of issue, by the Alumni Association of M.I.T.; Clarence L. A. Wynd, '27, President; H. E. Lobdell, '17, Executive Vice-president; Thomas F. Creamer, '40, William L. Taggart, Jr., '27, Vice-presidents; Donald P. Severance, '38, Secretary-Treasurer.

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The photo was made by pointing a camera up, at light coming through a tree, by Maurice K. Smith, '54, instructor in the M.I.T. Department of Architecture. Other "light" studies are on pages 20 and 21.

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The Institute's athletes have a gratifying record at mid-season.

Individuals Noteworthy

Honors

MEDALISTS and recent recipients of other distinctions recently announced include:

Victor P. Starr, '38, the Carl-Gustaf Rossby Award for Extraordinary Scientific Achievement, by the American Meteorological Society . . . *Jerome B. Cohen, '54,* the Robert Lansing Hardy Award, by The Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers . . . Professor *Jerrold R. Zacharias,* the Oersted Medal by the American Association of Physics Teachers.

New Posts

NAMED in the news recently were the Alumni whose elections, promotions, and appointments are reported below:

Augustus B. Kinzel, '21, as a Trustee, American Optical Company . . . *Frederick S. Blackall, Jr., '22,* as Chairman of the Board, Taft-Peirce Manufacturing Company . . . *Frederick B. Stevens, '23,* as Manager of Mileage Sales, Firestone Tire & Rubber Company . . . *Ralph F. Gow, '25,* as President, Norton Company.

George S. Mikhalapov, '26, as a Director, Beryllium Resources, Inc., Beverly Hills, Calif. . . . *Henry D. Johnston, '27,* and *Peter G. Volanakis, '42,* respectively, as President and Administrative Assistant to the President, Strathmore Paper Company . . . *Allen G. Shepherd, '30,* as Senior Metallurgist, Bostitch, Inc. . . . *Robert K. Wilson, '31,* as General Manager, Retailing Operations, Greater Boston area, Sears, Roebuck & Company.

Harry L. Moore, '32, as Eastern Regional Manager, Purchasing Department, Mobil Oil Company . . . *Charles P. Bowen, Jr., '35,* and *James A. Newman, '37,* as Managing Partners, Booz, Allen & Hamilton . . . *Russell W. Bandomer, '36,* as President, A. M. Kinney, Inc., Cincinnati, Ohio . . . *Wilbur F. Jordan, '36,* as Vice-president, Firestone Synthetic Rubber & Latex Company, Akron, Ohio.

David L. MacAdam, '36, as a Senior Research Associate, Eastman Kodak Company . . . *Ariel A. Thomas, '36,* and *Charles G. Hammann, '37,* as Senior Associates, Metcalf & Eddy, Boston, Mass. . . . *Horace B. Van Dorn, '37,* as Vice-president, Fafnir Bearing Company, New Britain, Conn. . . . *Saul P. Jacobson, '38,* President, Bowling Division, Brunswick Corporation.

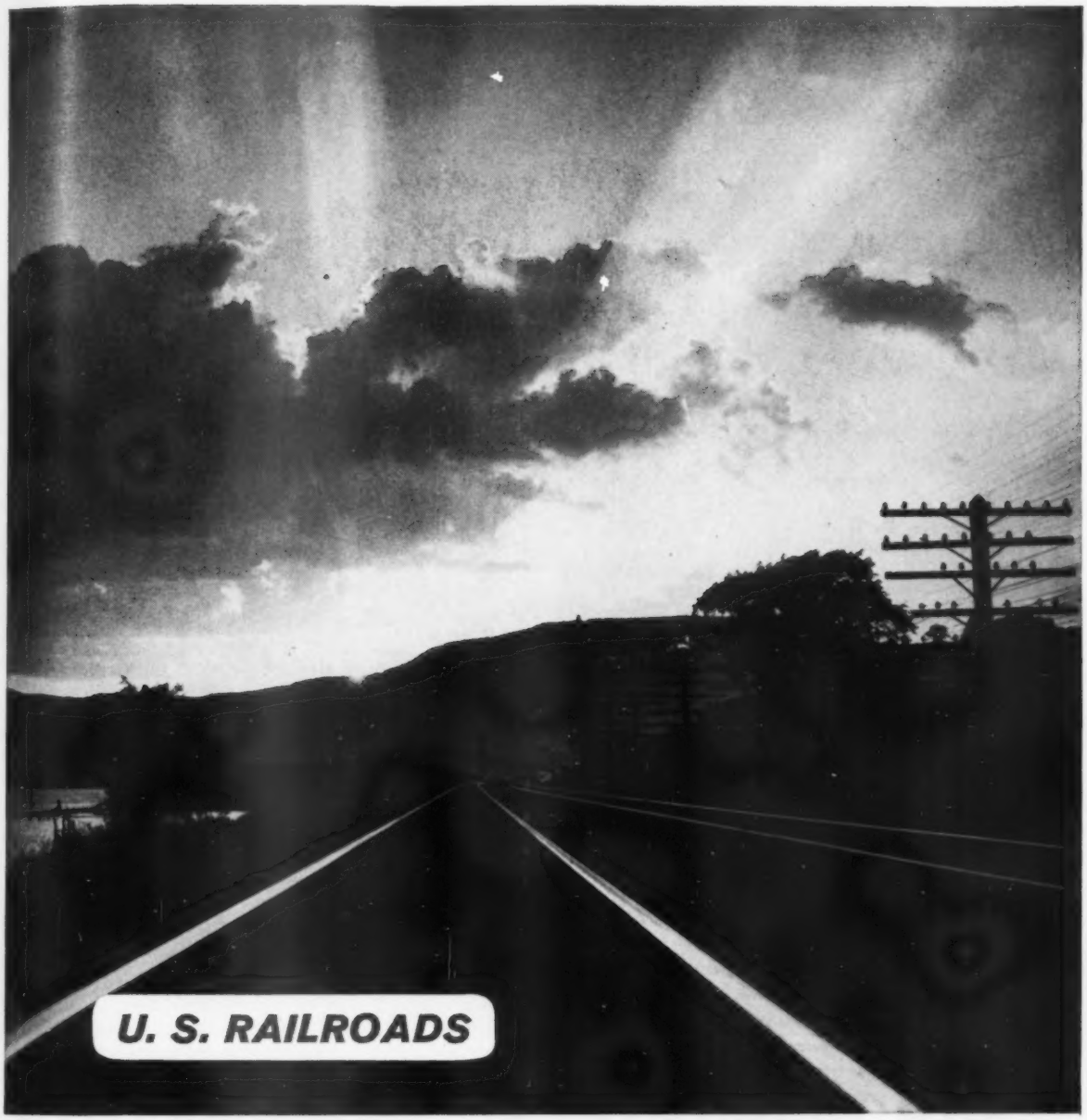
Warren H. Powers, '42, as Manager of Production, Maxwell House Division, General Foods Corporation, Hoboken, N.J. . . . *George F. Floyd, '43,* as Vice-president, Bissett-Berman Corporation, Los Angeles, Calif. . . . *Gilbert B. Devey, '46,* as General Manager, Vec Trol Engineering Inc., Stamford, Conn. . . . *Lloyd H. Perry, '46,* as Vice-president, U.B.S. Chemical Company, Cambridge, Mass. . . . *Gustavo U. Gross, '50,* as Governor of the State of Guayas, Ecuador . . . *William B. Martz, '50,* as Sales and Marketing Manager, Waters Manufacturing, Inc.

Robert W. Terry, '50, as Director of Engineering, Waveguide Systems Division, Microwave Associates, Inc., Burlington, Mass. . . . *William C. Plouffe, '51,* as a Director, Atkins & Merrill, Inc., Sudbury, Mass. . . . *Bruce E. Bidwell, '52,* as Vice-president, Bidwell Hardware Company, Hartford, Conn.

(Continued on page 6)

FEBRUARY 26 was the 100th birthday of Godfrey L. Cabot, '81, who posed for this photo at the 1955 Alumni Day Luncheon at M.I.T.

DEAN PIETRO BELLUSCHI of the M.I.T. School of Architecture and Planning headed the panel of judges for a proposed Franklin D. Roosevelt Memorial in Washington. He is pictured here (at left) with Francis Biddle, chairman of the Memorial Commission, and a model of the design the judges favored.



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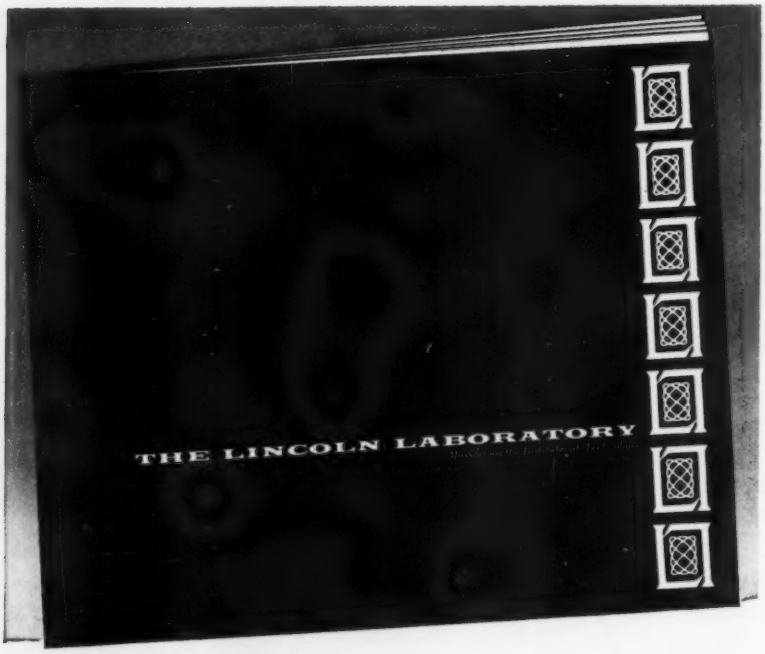

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Individuals Noteworthy

(Continued from page 4)

C. D. Howe: 1886-1960

A DISTINGUISHED Canadian statesman and member of the M.I.T. Corporation, the Right Honorable Clarence Decatur Howe, '07, died last December 31 in Montreal. He had held many important posts.

As head of his own company of consulting engineers, he played an important role in the economic development of Canada and in 1935 he was elected to the House of Commons as a member of the Liberal Party. At various times he occupied the posts of Minister of Railways and Canals, Minister of Marine, Minister of Transport, Minister of Munitions and Supply, Minister of Reconstruction and Supply, Minister of Defense Production, and Minister of Trade and Commerce.

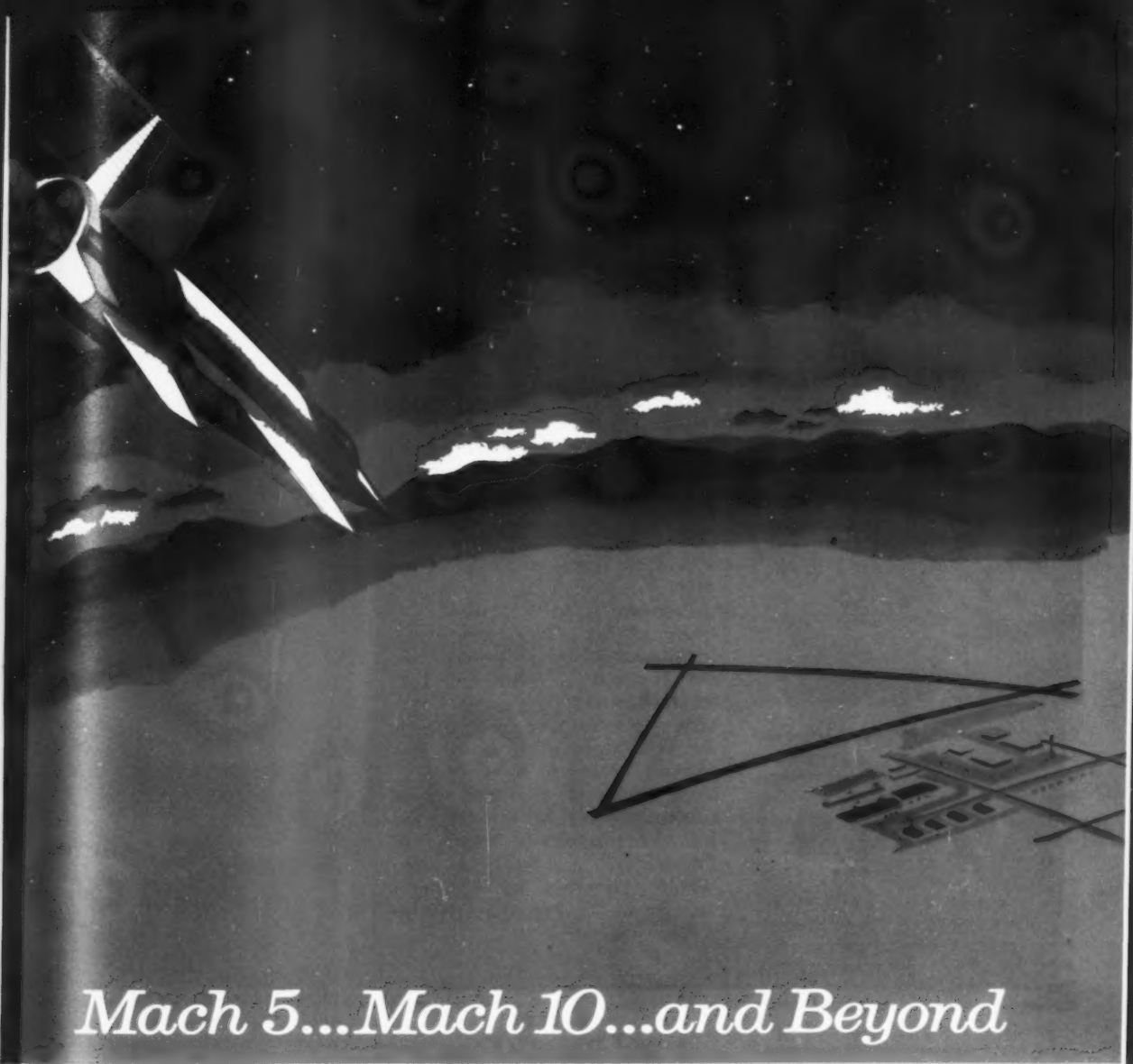
After the Conservatives came to power in Canada in 1957, Mr. Howe retired from politics and was chosen as chancellor of Dalhousie University, where he formerly had been professor of civil engineering. He held honorary degrees from a dozen universities and was a member of many of the leading engineering societies.

Mr. Howe was reputed to have wielded more power and spent more money than any other Canadian. The Montreal *Star* said he was "a man so big that his enormous impact on Canada is still hard to measure." And the Ottawa *Journal* observed that: "This master of organization and business management had a rich vein of sentiment, revealed by his lifelong pride in being a graduate of the Massachusetts Institute of Technology. He had planned with a classmate, Kenneth G. Chipman of Ottawa, to attend the 55th reunion of his class next year."

Born in Waltham, Mass., on January 15, 1886, Mr. Howe served briefly on the staff of the Department of Civil Engineering at M.I.T. before going to Canada. He became an alumni term member of the M.I.T. Corporation in 1953 and was elected a Life Member in 1958.

Mr. Howe is survived by his wife, the former Alice Martha Worcester of Waltham, two sons, and three daughters.

(Continued on page 8)



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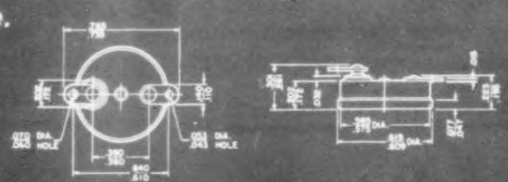

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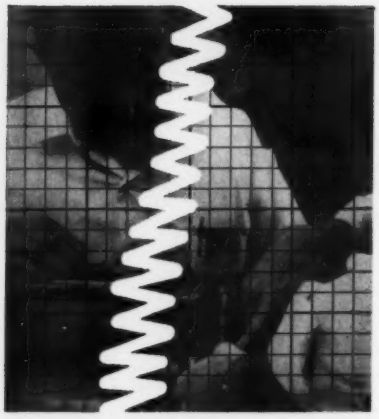

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Individuals Noteworthy

(Continued from page 6)

Faculty Notes

THE Atomic Energy Commission has appointed *Theos J. Thompson,* Director of the M.I.T. Nuclear Reactor, to an Ad Hoc Advisory Committee on the future use and disposition of the nuclear reactor involved in an accident at Idaho Falls in January . . . Professors *Walt W. Rostow* and *Giorgio de Santillana* will provide part of the text for *The Age of Change,* a pictorial history of the world since the great depression, to be published by Time, Inc. . . . Professor *Arthur C. Cope* is serving this year as President of the American Chemical Society.

President *Julius A. Stratton, '23,* spoke at the 150th anniversary ceremonies of Massachusetts General Hospital . . . Professor *Walter A. Rosenblith* participated in a computer techniques symposium at the February meeting of the Biophysical Society in St. Louis . . . Dean *George R. Harrison* was an editorial adviser for the McGraw-Hill "Encyclopedia of Science and Technology" . . . Professor *Jerrold R. Zacharias* has become a member of the President's Science Advisory Board.

(Continued on page 44)

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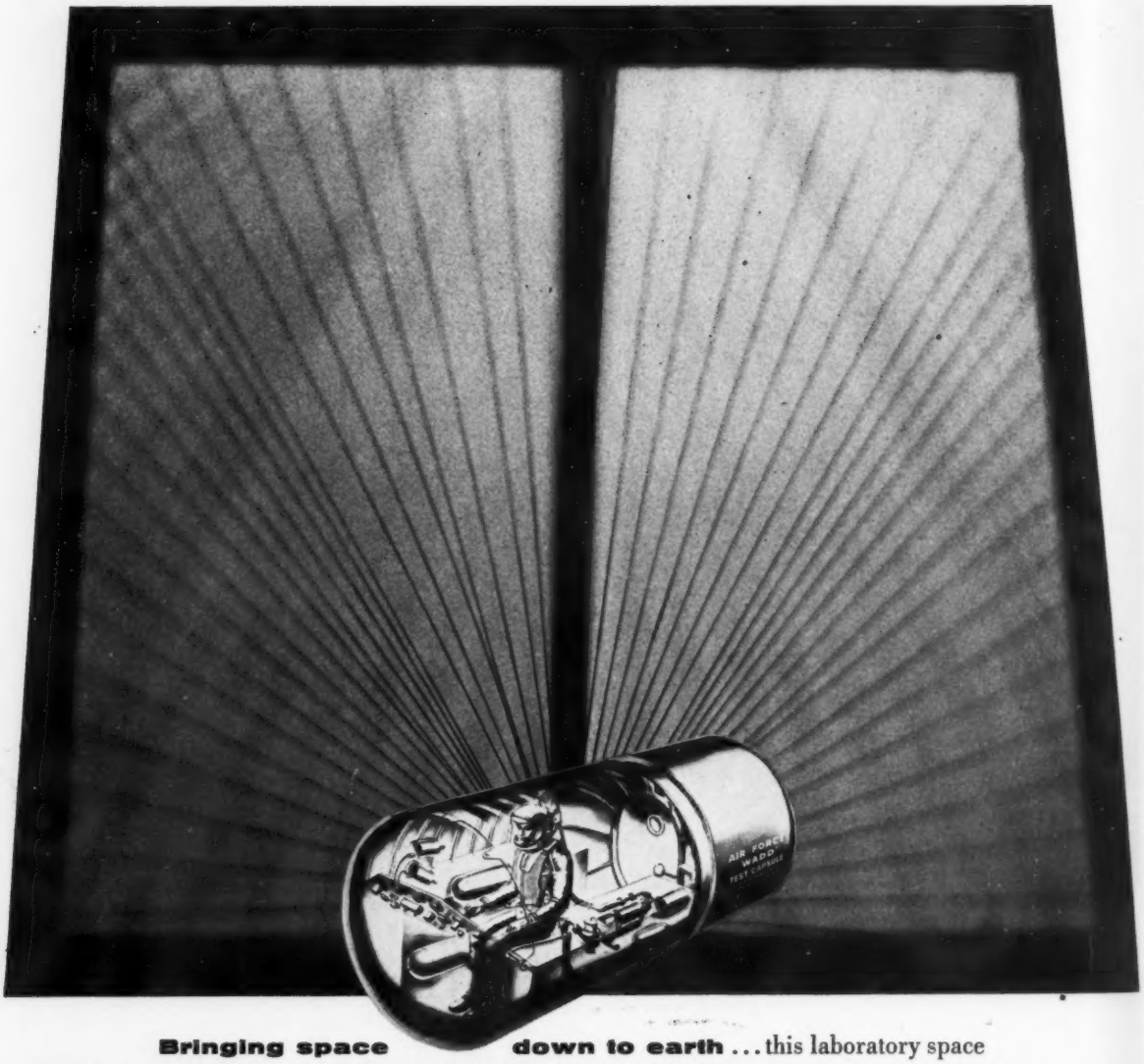

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M.I.T.'s Centennial Program

In April On Campus

THE CELEBRATION of the 100th anniversary of the founding of the Massachusetts Institute of Technology will reach its climax on Friday, Saturday, and Sunday, April 7, 8 and 9, when thousands of Alumni and eminent guests will attend a series of general assemblies.

Throughout the first two days visitors will hear members of the Faculty and distinguished visitors discussing great issues of the day. President Julius A. Stratton, '23, will deliver the final Centennial Week address at ceremonies on Sunday, April 9. Greetings from other universities will be brought in a formal academic procession at this time.

Alumni will dine together on campus following the President's reception on Saturday, April 8. Arrangements will be made for members of each class to sit together and some classes will have private rooms. The older groups will be at the Faculty Club, intermediate groups in the Walker Memorial Hall, and the younger groups at Baker House. The Alumni Association has reserved all of the dining places in these halls and in the Graduate House for this major social event of the weekend.

The concluding event, on Sunday evening, April 9, will be a Centennial Concert by the M.I.T. Choral Society in the Kresge Auditorium. Klaus Liepmann will conduct, and the society will sing Haydn's "The Creation."

On the preceding Sunday, April 2, about 100 of the world's most distinguished scholars, educators, and public officials will have met at Endicott House to begin an International Conference on Scientific and Engineering Education. This conference will continue through Thursday, April 6, and reports on it will be given at the general assembly on Friday, April 7. The reporters and some of the others who will participate in panel discussions on Friday and Saturday, April 7 and 8, are listed and pictured on the next page.

The Atoms for Peace Award

A PRIZE consisting of $75,000 and a gold medallion will be presented to Sir John Cockcroft at M.I.T. on April 6 during the celebration of the Institute's Centennial. This 1961 Atoms for Peace Award was announced in January, and will be presented at the Institute because of the great number of eminent scientists from all parts of the world who will be here then.

Sir John and E. T. S. Walton of Cambridge University were the first men to disintegrate atomic nuclei with artificially accelerated subatomic particles, and received the Nobel prize in physics in 1951. Sir John also directed Britain's development of radar and Canada's atomic energy program and later became director of the British Atomic Energy Research Establishment at Harwell. In 1959 he was appointed Master of Churchill College, a new science and technology foundation at Cambridge in England.

The Atoms for Peace Awards are a memorial to Henry and Edsel Ford and are administered by a nonprofit corporation. James R. Killian, Jr., '26, Chairman of the M.I.T. Corporation, is chairman of the trustees who make the award annually.

The M.I.T. Choral Society with Klaus Liepmann conducting will sing Haydn's "The Creation" at the Centennial Concert.

George W. Beadle

Louis I. Kahn

Paul J. Tillich

Paul M. Doty, Jr.

Centennial Speakers

Friday, April 7, four members of the M.I.T. Faculty will report on the international conference which will precede the Centennial assemblies. The reporters will be:

MARTIN DEUTSCH, '37, Professor of Physics.

MAX F. MILLIKAN, Director of the Center for International Studies.

WALTER A. ROSENBLITH, Professor of Communications Biophysics.

WALT W. ROSTOW, Professor of Economic History.

Saturday, April 8, there will be panel discussions, chairmanned by Elting E. Morison, Professor of Industrial History at M.I.T.

The three panels in the morning will be on:

- How Has Science in the Last Century Changed Man's View of Himself?
- The Future of the Arts in the World of Science and,
- The Future of Physical Sciences.

The panelists will be:

J. ROBERT OPPENHEIMER, Director and Professor of Physics, Institute for Advanced Study, Princeton.

PAUL J. TILLICH, Professor of Theology, Harvard.

JEROME S. BRUNER, Professor of Psychology, Harvard.

ALDOUS HUXLEY, author and Visiting M.I.T. Professor of Humanities.

HOWARD M. JONES, Lowell Professor of the Humanities, Harvard.

LOUIS I. KAHN, noted Philadelphia architect and chief critic of advanced architectural design at Yale.

SIR JOHN COCKCROFT, Atoms for Peace prize winner, Churchill College, Cambridge, England.

CHEN N. YANG, 1957 Nobel prize winner in physics, Princeton Institute for Advanced Study.

RUDOLPH E. PEIERLS, Professor of Mathematical Physics, Birmingham University, England.

RICHARD P. FEYNMAN, '39, Professor of Physics, California Institute of Technology.

The three panels in the afternoon will be on:

- Arms Control,
- The Life of Man in Industry, and
- The Future of Life Sciences.

The panelists will be:

PAUL M. DOTY, JR., Professor of Chemistry, Harvard.

RICHARD S. LEGHORN, '39, President of the Itek Corporation.

WILLIAM O. BAKER, Vice-president for Research, Bell Telephone Laboratories, and member of the President's Science Advisory Committee.

HERMANN J. MULLER, 1946 Nobel laureate in medicine and physiology and Professor of Zoology, Indiana University.

PETER B. MEDAWAR, 1960 Nobel prize winner in medicine and Jodrell Professor of Zoology and Comparative Anatomy, University College, London.

GEORGE W. BEADLE, 1958 Nobel laureate in medicine and physiology and Chancellor, University of Chicago.

JONAS SALK, physician and scientist, University of Pittsburgh.

HERMAN KAHN, The Rand Corporation.

WILLIAM H. WHYTE, JR., *Fortune* Magazine.

Peter B. Medawar

J. Robert Oppenheimer

Aldous Huxley

Jerome S. Bruner

eimer

REVIEW

The Centennial Conference

THE International Conference on Scientific and Engineering Education, which will precede the general assemblies during M.I.T.'s Centennial Week next month, has been planned by a committee headed by Professor Jerome B. Wiesner, who is now President Kennedy's scientific adviser.

The hundred participants will divide into four groups, each of which will consider a different aspect of the problem: One group will be concerned with the problems of scientific and engineering education in newly developing countries; another with such problems in more advanced countries; a third group with the interactions of science, engineering and society, and the fourth group with the implications of science and engineering for international relations.

Each group will include scholars from various parts of the world, and will discuss a set of background papers prepared and circulated in advance. The discussions of each group will be summarized at one of the general sessions, and reported later in a book to be published by The Technology Press. This book is expected to be an important contribution to the understanding of problems of scientific and engineering education throughout the world.

The main themes of the four sub-conferences have been formulated as follows by the steering committee:

Some Problems of Scientific and Engineering Education in Newly Developing Countries: The primary tasks in newly developing states are the building of modern governmental and private institutions; the training of modern men; the creation of adequate transport and power systems; the modernization of agricultural techniques; the development of natural resources. What is the role of the scientist and engineer in the fulfillment of these tasks? To what extent does their fulfillment require the focusing of talents on relatively simple, long familiar tasks of engineering? To what extent can more complex modern technology be exploited to facilitate the creation of these basic foundations for modern society? Should a more systematic and concentrated research effort be mobilized to deal with certain problems like energy supply, water conservation, and communications? To what extent does training abroad divert men from a concern with their own societies' problems? Are there advantages in creating local technological institutions, rather than sending men abroad? How might the traditional engineering education reflect the state of world science, and to what extent the state of the particular society? What kind of efforts should be made to develop a balance between the society's needs for different scientific and engineering talents and the supply from the education system? How can the more advanced technologies contribute to these problems of education?

Some Problems of Scientific and Engineering Education in Countries with More Advanced Technologies: The present rapid pace of technological change has led to the claim that many engineers are obsolete on the day of their graduation. Is this true? If so, what can we do to educate men to be effective through their whole life in a rapidly changing technology? Should there be changes in the relative roles played by undergraduate

(Continued on page 32)

Management and Computers: A Centennial Lecture Series

THE SCHOOL of Industrial Management has arranged for a series of eight lectures to be given at M.I.T. this spring on "Management and Computers of the Future" as part of the celebration of the Institute's Centennial. The first and second lectures will be given on March 9 and 13, respectively, at 8:00 P.M. in the Kresge Little Theater. Two others will follow in March, and there will be four in May. Topics, speakers, and chairmen will be:

Computers in the Educational Process, *by Prof. Alan J. Perlis, '49, Director of the Computation Center, Carnegie Institute of Technology.* Prof. Donald G. Marquis of M.I.T. will preside and Prof. Peter Elias, '44, of M.I.T., and Dr. J. C. R. Licklider of Bolt, Beranek and Newman, Inc. will be discussants.

Managerial Decision Making as a Feedback System, *by Prof. Jay W. Forrester, '45, of M.I.T.* Robert C. Sprague, '23, Chairman of the Sprague Electric Company, will preside and Prof. Ronald A. Howard, '55, of M.I.T. and Prof. Charles C. Holt, '43, of Carnegie Tech will be discussants.

Computer Simulation of Human Thinking and Problem Solving, *by Prof. Herbert A. Simon of the Carnegie Institute of Technology.* Prof. Sidney S. Alexander of M.I.T. will preside and Prof. George A. Miller of Harvard and Prof. Marvin L. Minsky of M.I.T. will be discussants.

A Library for 2000 A.D., *by Prof. John G. Kemeny of Dartmouth College.* Prof. William N. Locke of M.I.T. will preside and Prof. Robert M. Fano, '41, of M.I.T. and Dr. Gilbert W. King, '33, of IBM will be discussants.

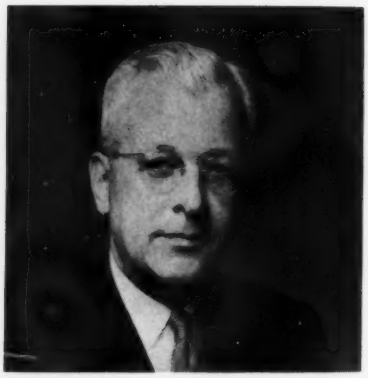
Scientists and Decision Making, *by Sir Charles Percy Snow of England.* Dean Howard W. Johnson of M.I.T. will preside and Prof. Elting E. Morison and Prof. Norbert Wiener of M.I.T. will speak.

The Changing Structure of Computer Programs for Describing Complex Processes, *by Prof. George W. Brown of the U.C.L.A. Graduate School of Business Administration.* Prof. Philip M. Morse of M.I.T. will preside and Prof. Michael P. Barnett of M.I.T. and Dr. Grace M. Hopper of Remington Rand will be discussants.

Trends in Computer Design, *by Prof. Nicholas C. Metropolis, Director of the Institute of Computer Research, Enrico Fermi Institute for Nuclear Studies, University of Chicago.* Dr. Emanuel R. Pierce of IBM will preside and Dr. Gene M. Amdahl of IBM and Prof. John McCarthy of M.I.T. will be discussants.

What Computers Can Do Better, *by Dr. John R. Pierce of the Bell Telephone Laboratories.* Dr. Vannevar Bush, '16, of M.I.T. will preside and Prof. Walter A. Rosenblith of M.I.T. and Prof. Claude E. Shannon, '40, of M.I.T. will speak.

Tickets will not be required, but Alumni wishing reserved seats may request them of the Centennial Lecture Series Committee, School of Industrial Management, Room 52-460, M.I.T.



John R. Kimberly, '26

Robert B. Semple, '32

William B. Bergen, '37

Alumni Association Officers Nominated

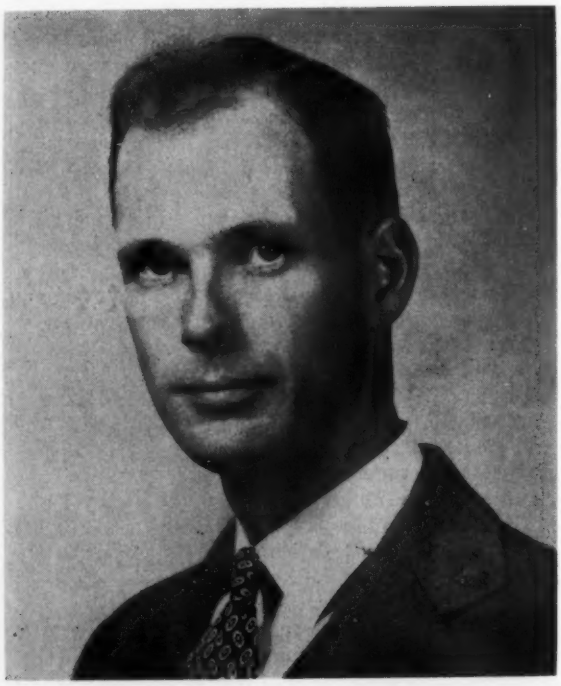
D. REID WEEDON, JR., '41, has been nominated to be the 68th President of the M.I.T. Alumni Association. Other names presented by the National Nominating Committee for the balloting this year follow:

For Vice-president, Carroll L. Wilson, '32.

For Executive Committee membership, Samuel A. Groves, '34, and Edward O. Vetter, '42.

For nomination as Alumni Term Members of the M.I.T. Corporation: John R. Kimberly, '26, Robert B. Semple, '32, and William B. Bergen, '37.

The President elected this spring will serve for one year, the Vice-president and Executive Committeemen for two years, and Alumni Term Memberships on the Corporation are for five years.



D. Reid Weedon, Jr., '41

Mr. Weedon is vice-president of Arthur D. Little, Inc., and a director of Arthur D. Little of Canada, Ltd. He has served the Association as Vice-President, Executive Committeeman, Alumni Fund Board member, Alumni Day chairman, and other capacities. He has been a class agent, reunion chairman, and class special gifts chairman. He is currently chairman of the Alumni Association Centennial Committee. Mr. Weedon is president of Phi Beta Epsilon and a member of many clubs and national organizations.

Mr. Wilson, who is now Visiting Professor of Industrial Management, was formerly assistant to Karl T. Compton and Vannevar Bush, '16. He was general manager of the U.S. Atomic Energy Commission from 1947 to 1951 and has held other government and industrial posts.

All three of the nominees for Alumni Term Membership on the Corporation are prominent in business:

Mr. Kimberly is chairman of the board of the Kimberly-Clark Corporation of Neenah, Wis., and the Spruce Falls Power and Paper Company of Toronto. He is a director of other concerns and a trustee of Lawrence College, the Rockefeller Foundation, American Forest Products Industries, the Episcopal Church Foundation, and the Institute of Paper Chemistry.

Mr. Semple is director and president of the Wyandotte Chemicals Corporation of Wyandotte, Mich. He has been president of his Class and is the Detroit Area chairman of the Second Century Fund. Mr. Semple is a director of several business firms and civic groups and is president of the Detroit Symphony Orchestra.

Mr. Bergen is president of The Martin Company of Baltimore. He is also a director of this company, the Baltimore National Bank, and the Black & Decker Manufacturing Company. He is chairman of the Baltimore section of the Second Century Fund, has been alumni representative on Visiting Committees, and is an honorary secretary for the M.I.T. Educational Council.

Nominees for three-year terms on the National Nominating Committee this year are John H. Holton, '17, Joseph Wenick, '21, C. Hall Baker, '22, Robert T. Dawes, '26, Gilbert M. Roddy, '31, Isaac H. Schwartz, '32, E. Philip Kron, '34, Armand L. Bruneau, Jr., '38, and Maxwell C. Coutts, '39.

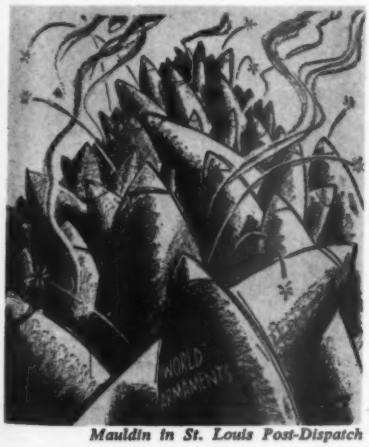
Arms Control: The Great Issue

The complexities of inspection, and need for more homework, are stressed by the M.I.T. men who conferred with the Russians

THE Pugwash Conference in Moscow last November 27 to December 6 was an unofficial meeting of physical and social scientists. They attempted at this meeting to define the points of disagreement between the Soviet Union and the United States about disarmament. M.I.T. Professors Jerome B. Wiesner, Walt W. Rostow and Alexander Rich, and Richard S. Leghorn, '39, participated in this conference, and also took part in a televised discussion of the disarmament problem after they had returned to Cambridge.

Inspection and the possibility of a nation retaining hidden stocks of weapons was the crucial issue discussed in Moscow; the complexities of this question were emphasized in the televised report on it in Cambridge. Brief excerpts from some of the M.I.T. men's remarks follow:

WIESNER: We, as an open society, are really continuously being inspected. In fact, we have military journals which do a better job of providing all the information than is needed. . . . The Soviets, for a variety of reasons, have depended to a very large degree on secrecy and have now developed what I call an almost paranoid fear of the consequences of too much openness while military power still exists.



Mauldin in St. Louis Post-Dispatch

Critical Mass

We, on the other hand, have developed tremendous fear of a surprise attack. We feel—and I think rightly—that accompanying any substantial disarmament there has to be a very substantial inspection. It is resolving this really serious difference in where our security comes from that the central problem of disarmament comes. . . . We are both going to have to do a great deal of technical studying and planning and military thinking before we can move forward in a really meaningful way.

To support our military strategy we have to have intelligence, and we pay a high price to get it. Therefore, it is militarily important for them to keep us from getting it.

LEGHORN: The Soviet military has a historic secrecy complex. In addition, the two main strategic values of secrecy to them are: (1) They have been covering up weakness—I am convinced that they still are. And (2) invulnerability—they are trying to hide their targets.

THE TV PROGRAM *entitled "Report from Moscow on Disarmament and World Security" was possibly the most significant single program ever telecast by WGBH-TV, according to Louis M. Lyons, this Cambridge educational station's news commentator. It lasted an hour and a half and a transcription of the participants' remarks totaled 15,000 words. This article includes only a fraction of that transcript.*

Two of the participants have prominent positions in the new administration in Washington: Professor Wiesner is President Kennedy's scientific adviser, and Professor Rostow is deputy to the President's special assistant for national security affairs. The Soviet Union was represented at the Pugwash Conference by equally eminent men.

The other discussants in the WGBH-TV program were Professor Alexander Rich of the M.I.T. Department of Biology, Professor Paul M. Doty of Harvard, and Richard S. Leghorn, '39, President of the Itek Corporation. Their moderator was Laurence W. Martin, Assistant Professor of Political Science at M.I.T.

ROSTOW: When I looked at my notes, I came to the conclusion that 90 per cent of the dialogue fell under one heading: "Soviet secrecy—relative secrecy—and its consequence for American policy and attitudes." This was the central theme, really, from beginning to end. Any technical issue you touch becomes caught up in it.

WIESNER: They are a proud people. They have made unbelievable progress, in my opinion, in the development of their country since the war. They were terribly devastated. They've done a lot of building, a lot of developing, but they also have very many areas where, I think, they are still quite ashamed of the situation. I think it would be wrong to conclude, as many Americans do, that the secrecy is all there because it is covering up a plan for surprise attack on this country.

☆ ☆ ☆

RICH: We have systems now in which one weapon has the potential ability to kill one, or a few million, people. This is several orders of magnitude greater than anything we had before. This has led to a military or strategic philosophy of

building up a sufficient number of weapons to deter an opponent from using them, and likewise on the other side. In a sense these two giant structures represent mutual deterrents and this would be a stable system if there were no perturbing factors.

The most obvious one is what's called the *n*th country problem. This is a slightly technical term, which refers to the fact that if two countries have atomic or nuclear weapons, one has to worry about a third country. At present there are four countries with nuclear weapons, so the *n*th country problem is really the fifth country problem today. When a fifth country has it, it will be the sixth. This is a problem that all of us worry about. It is a problem that the Russians seem particularly worried about, I think.

WIESNER: In all science and technology, it is doing something the first time that is extremely difficult and takes a few strokes of genius and brilliance. Doing it the second time is a good deal simpler.

ROSTOW: As the Soviets put it to us, we each have allies whose acquisition of these weapons would gravely complicate our lives. . . . The Soviet Union is worried about Germany and about China. . . . It's a question of the kind of power and control over your own destiny you can exercise in a situation where war can be triggered by random circumstances.

WIESNER: Nuclear weapons are a great equalizer, in much the same way that the revolver was in the wild West. You don't have to be six feet tall and weigh 240 pounds if you have a gun in your hands.

RICH: Another hazard is inherent in the weapons system: If you believe you are being attacked, you are required to respond very quickly. . . . Technological error comes in here . . . There is also the phenomenon of psychosis, where an individual in charge of a missile or submarine is mentally unbalanced, and this triggers off a war.

WIESNER: It's a question of how rational you will be if there is an accident. . . . If one of our cities or one of theirs is destroyed by accident there is no means of rapid communication that I know of that will stop some form of retaliation.

ROSTOW: I think that the Soviet delegates communicated—I think under instruction, but nevertheless with great clarity and conviction—an array of concerns which very much match the array of concerns that any group of Americans would come up with: (1) the *n*th power problem; (2) the accidental war problem, and (3) the technological dead-end character of this thing combined with its growing costs.

☆ ☆ ☆

WIESNER: Through the years both we and the Soviets have oscillated between talking about quite limited measures in inspection and very elaborate measures. . . . I feel very strongly that I would not recommend any disarmament proposals to this country that didn't have fairly secure safeguards, but the kind of safeguards you need depends on the particular measures you are talking about.

If you are talking about limited measures, and violations could not be very serious threats to your national survival, the amount of inspection you require is different than if you are talking about total disarmament—which some of us believe not only requires a very considerable amount of inspection, and careful planning of inspection, but in fact even requires something beyond that: namely, some form of international security, which the Soviets are just now really beginning to talk about being willing to discuss.

I myself feel that we will pass to that stage slowly, and go through fairly comprehensive—but not zero or total—disarmament first, and then work out confidence-building schemes.

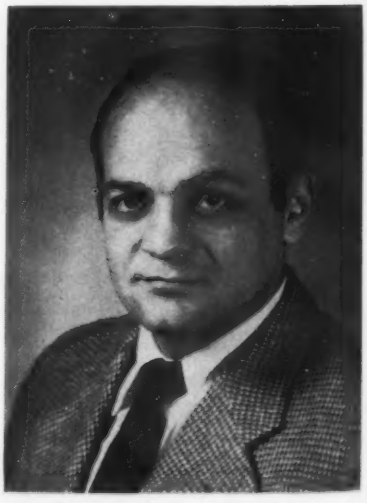
One of the important things to realize is that the amount of inspection we need is a function of just how much you want to disarm. We have both, in a sense, limited our arms today, because we have not built an infinite amount of military power, and we have a certain amount of inspection—it is unilateral, it is intelligence essentially, and it is what each of us is willing to tell the other.

Suppose that each country agreed that it was going to declare the size of its missile force and then on some programmed time scale reduce it. If the prior declaration by us or by them was wrong and if you were

(Concluded on page 38)

Professor Jerome B. Wiesner

Professor Walt W. Rostow



Professor Alexander Rich

Trend Of Affairs

The Three-Deckers of Boston

MANY of our housing problems have been created by prosperity rather than poverty, Professor Lloyd Rodwin of M.I.T. suggests in a recently published history of the housing of Boston's middle-income families.*

Boston's thousands of three-deck houses have been ascribed to an architect's mistake. Professor Rodwin, however, traces their popularity to the enactment of a building code which defined a house occupied by more than three families living independently as a tenement.

"Rather than risk the possibility of overpricing their market by erecting costly new legal tenements," Professor Rodwin writes, "builders and petty contractors resorted to two-family and three-family houses as inexpensive and altogether legal alternatives. Easy to put up, cheaper to sell, in several respects relatively better places in which to live, these structures sprouted almost everywhere."

In addition to reviewing their rise, his new book, *Housing and Economic Progress,* describes the growth of building and loan associations, tenure attitudes, and population shifts in Boston, in ways that are certain to interest everyone interested in real estate everywhere.

Economic progress, Professor Rodwin writes, has prompted or accentuated "the growth of families, rising standards of demand, the desires and problems of ownership, shortages of housing, controversy over rent controls, debate about suburbia, the dilemma of our 'gray' areas, and the current evangelical efforts to make our existing cities more delightful and efficient places."

He has focused attention on middle-income families "in the twilight zone between renting and ownership and between the families who need no assistance and those who require very special assistance." Such families now live in or are leaving "the miles of dingy neighborhoods meeting minimum standards, but not sufficiently adequate or attractive for their residents as standards of demand rise." The homes these families leave can serve lower-income families, and existing housing tools might be deployed effectively to serve the "transitional" population seeking better housing.

But whatever is done, Professor Rodwin warns, housing problems are more likely to be transformed than solved. "Only in a stationary society," he writes, "is it likely that there will be no significant discrepancies between rates of change of family income, standards of demand, and achievable conditions of housing; only in a very wealthy society are these discrepancies unlikely to be matters of genuine concern; and only in utopias can we be sure that our ingenious solutions will not occasionally bomerang . . ."

Once nearly half of Boston's dwellings had three decks.

Public Policy Conference

PRINCIPAL officers of companies participating in the M.I.T. Industrial Liaison Program spent the weekend following President Kennedy's inauguration discussing science and public policy at M.I.T. Speakers included Vannevar Bush, '16, James R. Killian, Jr., '26, and James McCormack, Jr., '37, of M.I.T. and Professor George B. Kistiakowsky of Harvard. Panel discussions were led by Dean John E. Burchard, '23, and Professor Ithiel D. Pool. The discussants included Professors Max F. Millikan, Robert M. Solow, Donald G. Marquis, Robert C. Wood, and Peter Elias, '44; Alexander G. Korol of the Center for International Studies, Dean Harvey Brooks, '45, of Harvard, and Patrick E. Haggerty, President of Texas Instruments, Inc.

* "Housing and Economic Progress," published for The Joint Center for Urban Studies of M.I.T. and Harvard (Harvard University Press and the Technology Press, $7.50).

The Wiesner Report on Space

WHEN President Kennedy made Professor Jerome B. Wiesner of M.I.T. his scientific adviser, he also released the report of a task force headed by Dr. Wiesner which had reviewed the nation's space program for him. M.I.T. was also represented on this task force by Edwin H. Land, Visiting Institute Professor; Bruno B. Rossi, Professor of Physics, and Harry J. Watters, '53.

Although the group found that "our scientific program in space appears to be basically sound" and "we now hold a position of leadership in space science," it reported that "the nation's ballistic missile program is lagging" and "it is very unlikely that we shall be first in placing a man into orbit around the earth." The emphasis on the latter, the task force said, has tended to obscure "solid, durable, and worthwhile goals" such as an international television relay system, more knowledge of meteorology, and telescopes aboard satellites.

The report cited five reasons for having an effective space program: prestige, national security, scientific research, practical nonmilitary applications, and the "exciting possibilities for international cooperation with all the nations." To make the U.S. program more effective, it recommended organizational and managerial changes and such steps as "rapid development of boosters with a greater weight-lifting capacity," encouragement of "entirely new ideas which might lead to real breakthroughs," and efforts "to make space activities attractive to a larger group of competent scientists and engineers."

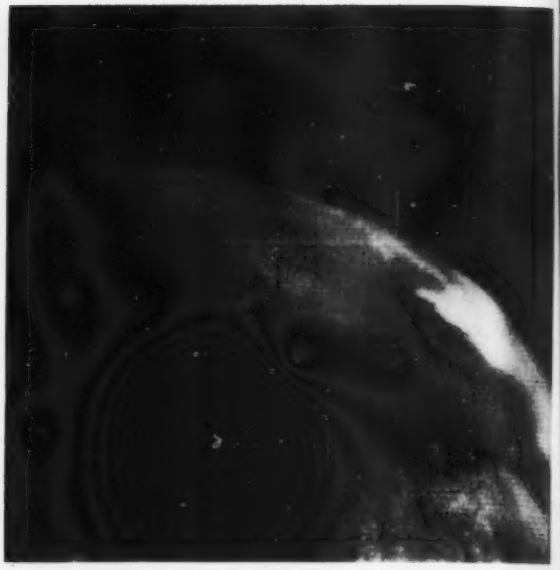
In reviewing the many potentialities of space work, the report said: "There is the distinct possibility that planetary exploration may lead to the discovery of extraterrestrial forms of life. This clearly would be one of the greatest human achievements of all times."

An International Youth Service

THE PEACE CORPS plan drawn up for President John F. Kennedy by Max F. Millikan, Director of the Center for International Studies at M.I.T., would match the enthusiasm and dedication of young Americans with the man-power needs of underdeveloped countries. Thus it would (1) accelerate the development of those countries, (2) increase their people's understanding of our goals, and (3) both provide constructive opportunities for our young people and acquaint more of them with conditions elsewhere in the world.

In a memorandum circulated last winter, Professor Millikan suggested the establishment of a new International Youth Service Agency. It would provide funds for universities and other nonprofit organizations to arrange for the employment of qualified young Americans by foreign governments and institutions. They would help meet locally felt needs for assistance in carrying out educational, health, agricultural, industrial, and other programs.

"Most of these countries," he wrote, "are developing plans for the training of suitable numbers of their own citizens to fulfill these functions, but because training and education are inherently slow processes with long lead times the flow of indigenous personnel will be grossly inadequate in the early years. This gap in available skills could be at least partially filled and the modernization of these societies, so critical to their stability, accelerated if they could make use of substantial numbers of people from the developed countries. The needs vary from one underdeveloped country to another, but in almost all there will be for at least the next decade serious shortages of trained people at all levels of education and experience. Preliminary studies in a few of these countries have established clearly that a part of this need could be met by young people with the equivalent of bachelor's or master's degrees in a wide variety of different fields."



Florida and clouds in the distance as seen from TIROS I.

Professor Millikan proposed that the men sent should be required to commit themselves to serve for two years, and not be exempted from selective service obligations. He emphasized the importance of careful selection, proper preparation, and adequate supervision of the participants. The program's value would be reduced, he warned, if it resulted in establishment of substantial American communities abroad. It should be a part of the broader American effort to help underdeveloped countries, he contended; and the new agency, in addition to surveying needs abroad, should look for ways in which foreign students sent to this country could perform reciprocal services.

Such a program could be launched experimentally at once, he believes, then closely studied and evaluated so that it could be expanded in the light of experience.

Architects Hail TV Program

AT THE American Institute of Architects' meeting in Philadelphia in April a Special Citation will be given to the CBS television program, "Big City 1980," which was produced in association with M.I.T. Deans John E. Burchard, '23, and Pietro Belluschi of M.I.T. appeared on this program with Edmund Bacon, chairman of the Philadelphia Planning Commission, and Garry Moore of CBS. It dealt with the question: Will tomorrow's cities contain the best elements of today's cities, or merely compound the worse? Without doubt, said the *A.I.A. Journal*, this program advanced public understanding and appreciation of architecture.

From Smells to Airfoils

STUDY of olfactory stimulation, in the Research Laboratory of Electronics at M.I.T., has resulted in the development of a novel aid to designers of ships, aircraft, and other vehicles. It is a refined, electrical way of making the fields of flow in a liquid clearly visible. Demonstrations of the technique by Walter Pitts, Bradford Howland, and Robert C. Gesteland, '57, in the laboratory's neurophysiology section have intrigued both engineers and artists.

The researchers were concerned originally, and still are, about what happens in one's nose when chemical information is turned into electrical information for transmission to the brain. While trying to devise a model of this biological process, they looked into the electrochemical effects of fluid motion past an electrode.

Luminescent chemicals have long been known. By placing them in a solution and moving an anode through it, or permitting it to flow past an anode, it was found that some of these chemicals could be triggered into glowing. The shape of the electrode, as they now show in their demonstrations, can be that of a cylinder, a sphere, a blade, an airplane wing, or whatever one wishes to study. The glow reveals the detailed structure of the flow pattern. An advantage of this technique is that the luminescence begins right at the surface of the electrode, and its extension into the wake can be controlled by varying the contents of the fluid and the voltage in the circuit.

A photo of the glow of a solution flowing past an anode.

Photographs of the luminescence in the fluid are often quite beautiful as well as likely to be helpful in demonstrating and measuring hydrodynamic effects. In addition to photographing turbulence of various kinds, Mr. Howland has obtained pictures of the spiraling trails called the "von Kármán vortex streets."

Technical details of the method were given in recent RLE progress reports. The work was supported in part by Bell Telephone Laboratories, Inc., the National Institutes of Health, and the Teagle Foundation, Inc.

Professors F. K. Bentley and W. Prichard Jones with Donald P. Germeraad, '50, and Professor Otto C. Koppen, '24, at a Department of Aeronautics and Astronautics seminar.

Professor Manson Benedict, '32, John W. Weil, '48, with Robert B. Flanders, '58, and Richard I. Buckley of Texas Instruments, Inc., at a nuclear reactor seminar.

Advice from Alumni

EVERY WEEK the M.I.T. Calendar of Events lists seminars and lectures on a great variety of topics, and the speakers often are Alumni. In January, for example, John W. Weil, '48, spoke on "The Dresden Power Station" at a Department of Nuclear Engineering seminar, and Donald P. Germeraad, '50, spoke on "A Test Pilot's Role in Transport Airplane Design" at an H. N. Slater Flight Transportation seminar.

Dr. Weil who is with the Atomic Products Division of the General Electric Company, in San Jose, Calif., discussed phenomena which must be considered in the operation and control of very large nuclear reactors.

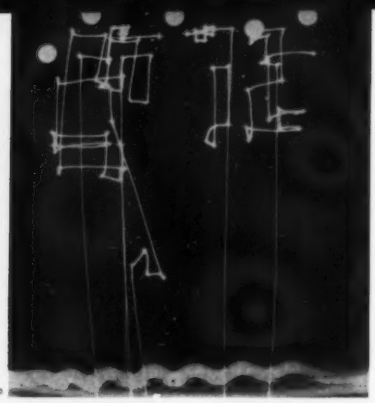
Mr. Germeraad is chief test pilot for Convair's San Diego division and described his experiences with the Convair 660, 880, and 990 series of jets. He emphasized the importance of familiarity with the design of the plane that one is testing and the importance of reporting every reaction to a flight.

Lively discussions often follow lectures in such seminars.

Basic Textile Engineering

IN THE December 15, 1960, issue of *America's Textile Reporter,* Peter M. Strang, '18, pointed out how basic engineering concepts, such as those of fluid mechanics, can explain machine-fiber interactions in carding, an important textile operation. His study exemplifies one phase of present thinking in the textile division of the Department of Mechanical Engineering at M.I.T. This correlation of the present state of the art of carding cotton with a scientific theory should help furnish a basis for future developments.

(Trend of Affairs is continued on page 40)



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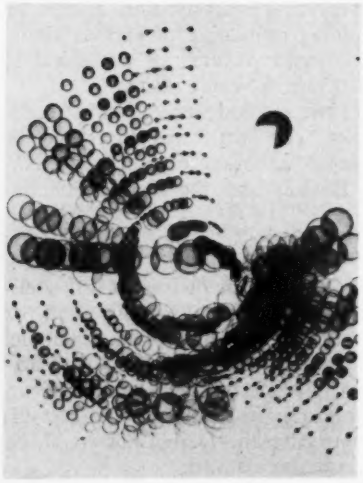
Experimenting With Light



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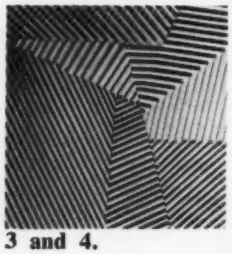

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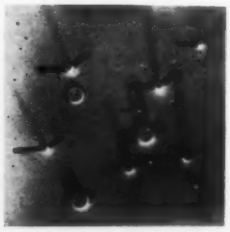

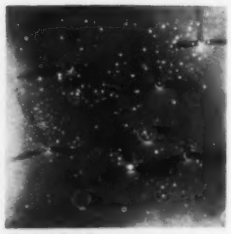

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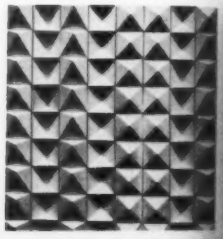
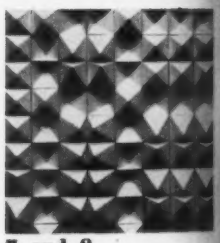




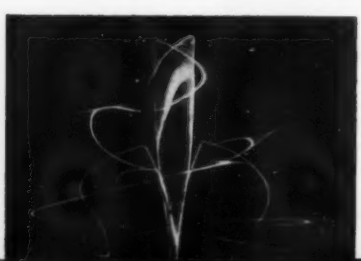
7 and 8.

1. A drawing made with a flashlight (Gerald Ervin, '59). 2. A photogram made by exposing sensitized paper directly to light without a camera (Michael B. Flint, '59). 3 and 4. Modification of a surface pattern by changing light (Ki Suh Park, '59). 5 and 6. Changing emphasis by changing front and rear lighting (Park; and Leonard Saulnier, '59). 7 and 8. Modification of surface pattern by rearranging units in the same light (Barrios R. Parada, G). 9. Virtual volume—wire sculpture photographed in motion (Franklyn Williams, '59). 10. Experiment with light related to mirroring surfaces (Robert N. Fisher, '61). 11. A three-paneled mural with emphasis on continuity achieved by light (E. Haladay, '60).

ARCHITECTS and planners demand more than comfort and amplitude in lighting: they realize the immense opportunities in designing with light. But knowledge of how to take full advantage of these opportunities is still needed.

In Light and Color classes in the School of Architecture at M.I.T., an effort is made to develop creative understanding of light: With a camera as a research tool, the orchestration of light is studied. These photographs, chosen by Gyorgy Kepes, Professor of Visual Design, and Assistant Professor Robert O. Preusser, are examples of work done by students in these classes.

"The imaginative use of light has been until now a neglected area in design," says Professor Kepes. "The creative use of light can be developed further in directions we have not even begun to explore, and an undreamed of wealth of aesthetic experience awaits us."



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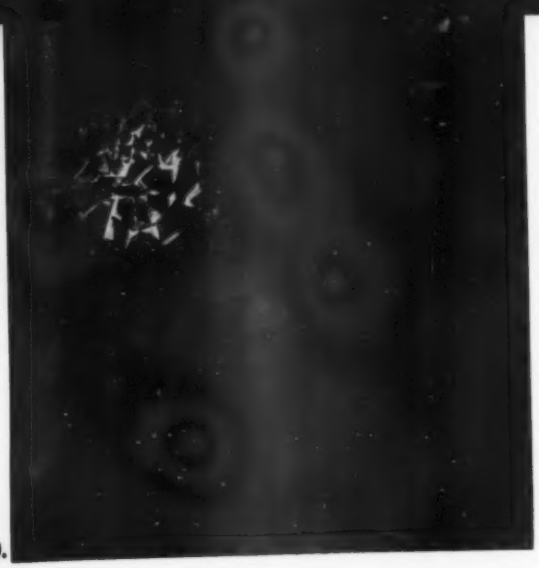

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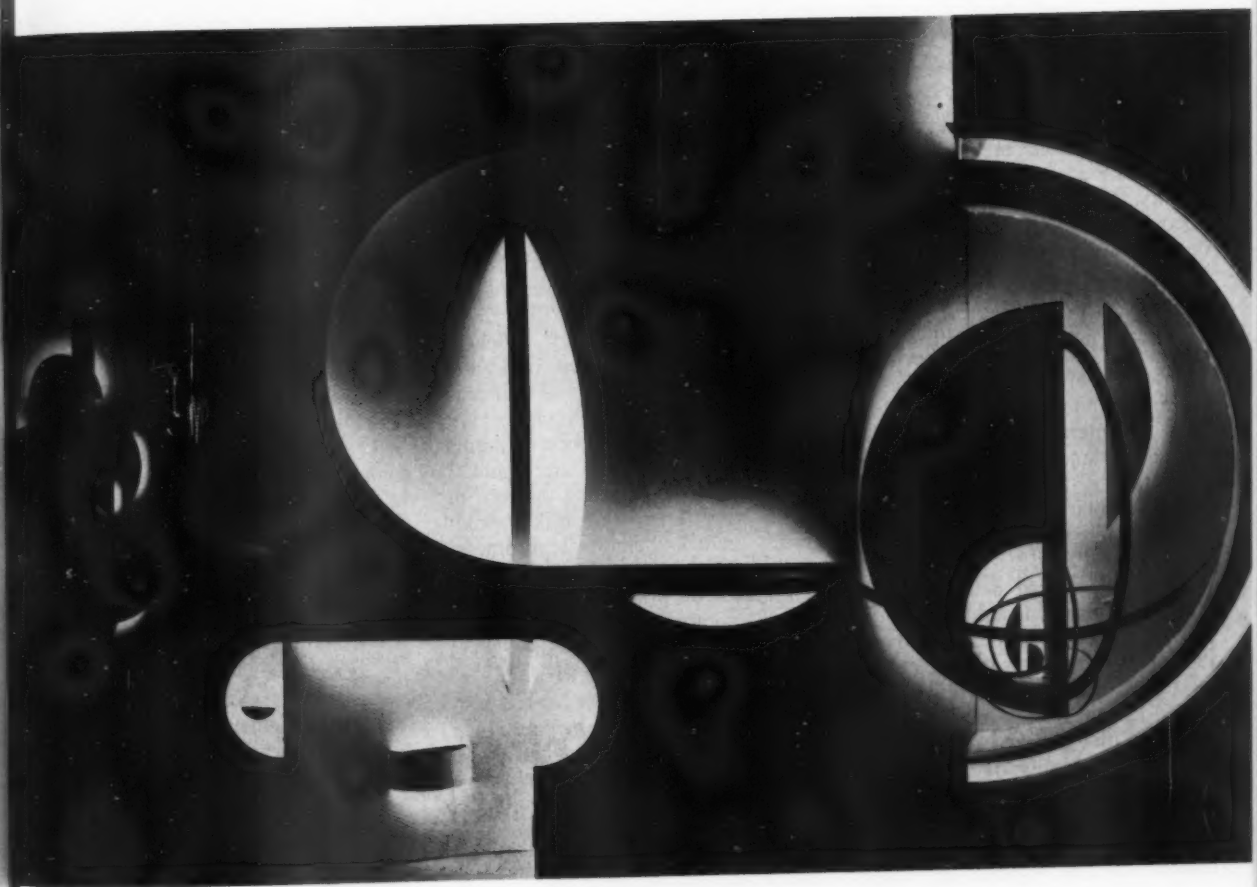

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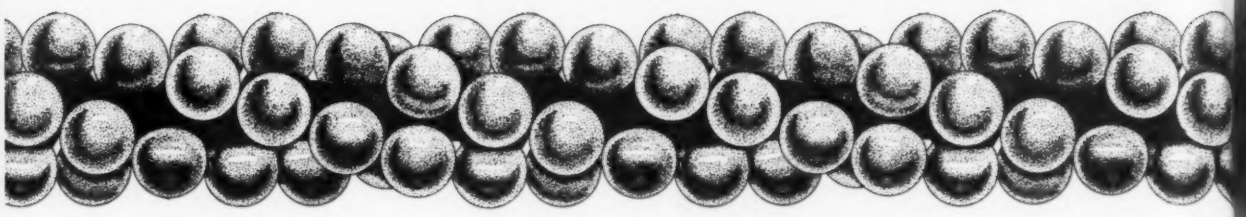


The Growth of Polymer Science

A new family of materials, made of long, tailored molecules, has gained importance rapidly, and its future is still promising

BY F. W. BILLMEYER, JR., AND A. S. MICHAELS, '44

Of the Department of Chemical Engineering, M.I.T.

THE TERM "Materials . Science" has gained prominence recently both in the public press and within the scientific and engineering community. "Materials" have been defined by a Faculty study group under the direction of Professor Morris Cohen at M.I.T. as "substances or aggregates whose properties make them useful to mankind for structures, machines or devices." The science of materials can thus be defined as the systematic development of interrelationships between the atomic and molecular structure of materials, their end-use properties, and their response to the environment in which they are fabricated and utilized.

These are broad definitions and encompass an enormous field of study. It may, therefore, be advantageous to form a picture of the field as a whole through the examination in some depth of a small but representative area of it.

One such family of "materials," whose practical utility is acknowledged by engineer and layman alike, is the class of substances designated by the scientist as "polymers." The fabrics that clothe us, the wood of our houses, the rubber tires on which we ride, the plastic containers that protect our food—indeed, the very sinews of our bodies—are polymers.

Like all other forms of solid matter, polymers are composed of aggregations of atoms; but they differ from metals and masonry, in which the atoms are arranged in highly ordered three-dimensional patterns known as crystals. Polymers are comprised of small groups of atoms (called "mers") which are connected together bead-string-fashion to form very long, threadlike structures called "chain macromolecules." The dimensions of the chain molecules of which a typical polymer is composed are impressive: if such a molecule were magnified about 15 million times, it would resemble a strand of well-cooked spaghetti about half a mile long! In a single cubic inch of a polymer, about 20 billion billion of these chainlike molecules are intertwined and tangled with one another; electrical forces acting between the chains cause them to stick together, imparting to the material a combination of properties which no other class of solid or liquid substances possesses.

The elasticity and abrasion resistance of rubber, the strength and toughness of synthetic fibers, the stickiness of adhesives, the flexibility and clarity of photographic film—all of these properties are intimately associated with the long-chain nature of polymer molecules. The ability of the chemist and chemical engineer to tailor-make such molecules from an immense number of different raw materials, to control their size within close limits, and to alter at will the forces acting between them, constitutes one of the major technological triumphs of the century, and provides the keystone of the modern plastics industry.

Rubber, Celluloid, and Bakelite

While an awareness of the chainlike nature of polymers and of the interrelationships between their properties and their structure has developed only in the last 40 years, man's utilization of polymeric materials

has a long and fascinating history. In prehistoric times, our forebears relied upon hides, fur, and wood for survival. Asphalt and natural gums such as the sticky exudates from conifers are mentioned in prebiblical records. Wool and flax have clothed man for thousands of years. Cultivation of the silkworm in China is traced back to 2640 B.C., and the art of papermaking, to the first century A.D. Rubber was "discovered" by Columbus on his first New World expedition, although how long this substance had been known to the Brazilian and Caribbean Indians never has been established.

The beginnings of the modern plastics industry lay in the utilization of natural rubber for erasers and rubberized fabrics—strangely, not until some 300 years after Ferdinand and Isabella scoffed at the Old World's first rubber ball. The first major breakthrough in the utilization of rubber did not come until Goodyear's accidental discovery of vulcanization in 1839, which led to the development of a major new industry in England and the United States. Commercialization of many other modified natural products (such as "Celluloid") and the first truly synthetic plastics (Baekeland's "Bakelite" phenolic resins) followed quickly on the heels of the rapidly expanding rubber industry, so that by the end of World War I, a vigorous new chemical industry was in the making. Yet despite its rapid growth, the industry was guided much less by scientific principles than by art and empiricism. Few people knew or cared much about what was actually going on in the steaming tanks from which the sticky goos were drawn, or why these products behaved as they did. The term "polymer," and the concept of the chain macromolecule, were still nonexistent.

At this time, Warren K. Lewis, '05, of M.I.T.'s then fledgling Chemical Engineering Department, saw the opportunity—through his professional contacts with the paper, leather, and rubber industries—to establish an educational position in an area which most scientists of the day regarded with derision. Dr. Lewis' subject, "Industrial Chemistry of Colloidal and Amorphous Materials," dealt in an imaginative way with the physics and chemistry underlying such poorly understood phenomena as the vulcanization of rubber, the tanning of hides, and the hydration of cellulose fibers.

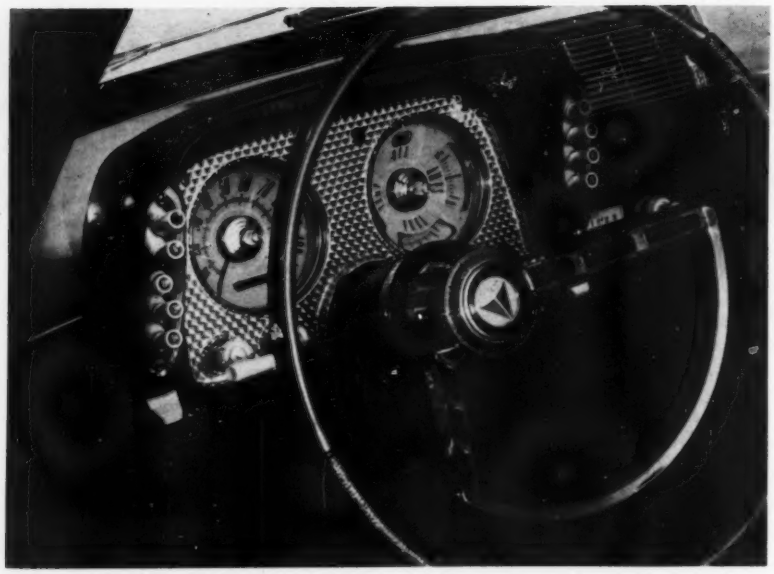
The establishment of this course of instruction in 1920 proved to be a milestone in the teaching of applied polymer chemistry. The Lewis inspiration had its enduring impact upon the staff, students, and chemical industry, with the result that formal instruction and active research in this area have continued to grow and expand with the times; today, the Department of Chemical Engineering at M.I.T. offers no less than five elective subjects relating to polymers and colloids, and nearly half of its Faculty are to varying degrees engaged in research in these fields.

Macromolecular Architecture

At the same time that Lewis was launching his educational experiment in Cambridge, Herman Staudinger in Germany was laying the foundations of modern polymer science with a monumental series of experiments proving the existence of long-chain molecules, which were to earn him the Nobel prize in Chemistry in 1953. In 1920 he proposed long-chain formulas for several polymers, and his extensive investigations left no doubt as to their long-chain nature. More careful molecular weight measurements substantiated Staudinger's conclusions, as did x-ray studies showing structures compatible with chain formulas. The outstanding investigations by P. J. Flory and W. H. Carothers in this country beginning in 1929 supplied quantitative evidence substantiating the macromolecular viewpoint, by demonstrating that large, chainlike molecules could be made by any of a variety of well-established organic reactions.

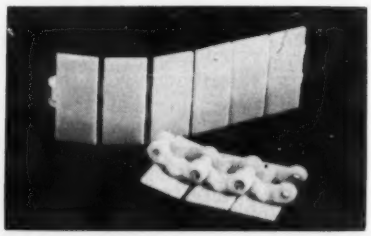
The subsequent progress of polymer science from the early work of Staudinger, Flory, and Carothers can be followed along two major lines of endeavor: the development of an understanding of the relationships between the macroscopic properties of plastics, resins, fibers, and elastomers and their molecular architecture; and the discovery and development of new or improved techniques for the chemical synthesis of polymers from a wide variety of raw materials. The former constitutes the rapidly growing field of polymer physics, and the latter, polymer chemistry.

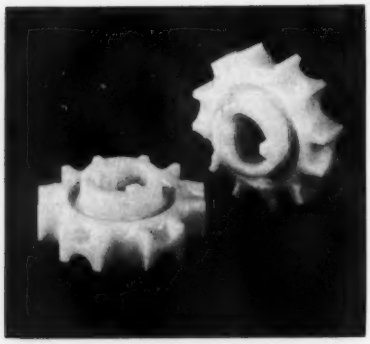
It is now well established that such important end-use properties of a polymer as strength, flexibility, toughness, solvent resistance, and heat resistance are related in rather

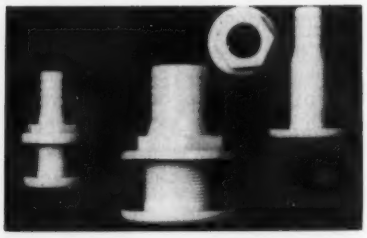


Some of the Uses for Polymers Now

Long molecules such as you saw on the preceding pages are used in auto steering wheels and dashboards. Some of the many other forms in which you encounter these plastics are shown at the right and below.







predictable ways to the size of the molecules comprising the material, the atomic make-up of the building blocks or "mers" which are strung together to form the molecules, and the degree of regularity with which these building blocks are interconnected. At elevated temperature, for example, the fluidity of a molten plastic is determined largely by the length of the chain molecules of which it is composed. Molecular size thus determines to a large degree how easily a plastic may be fabricated, and also at how high a temperature it may be used as a structural material without undergoing serious distortion.

As a plastic melt is cooled, forces between adjacent molecules come into play which retard slippage between chains, but may not be sufficient to prevent rather long segments of chains from moving relative to one another under stress; under these conditions, the polymer exhibits a high degree of resiliency or rubberiness. Further cooling in most cases causes further reduction in inter-molecular mobility, and the material passes through a leathery to a brittle or glassy state. The temperature levels at which a particular polymer experiences these transitions in mechanical behavior are controlled by the magnitude of the forces acting between molecules, which in turn is uniquely related to atomic composition.

Many polymers whose molecules possess a high degree of structural order undergo an interesting and important change as they cool from the melt: the chain molecules associate intimately and regularly with one another in the form of small crystallites, which impart to the solid a surprising degree of toughness and strength. Such crystalline polymers, exemplified by polyethylene and nylon, account for virtually all natural and synthetic fibers, and are receiving increasing attention as super-strength plastics for use as metal substitutes. Elucidation of the microstructure of these polymers is one of the most active and exciting aspects of polymer physics today, and recent discoveries relating to the crystallization phenomena and resulting polymer morphology portend the development of materials with heretofore unattainable mechanical and thermal properties.

Newly Exploited Reactions

In polymer synthesis, accomplishments over the past 20 years, and particularly during the last five, have been equally dramatic. Flory's so-called vinyl polymerization, which had its beginnings in the manufacture of polystyrene, has now expanded to include an impressive array of familiar plastics and elastomers. Such important products as butadiene-styrene rubber, polyethylene, poly(vinyl chloride), and the acrylic resins are vinyl polymers manufactured today on a massive scale. Carothers' methods, which led directly to the synthesis of nylon, have more recently been improved and extended to the manufacture of poly(ethylene terephthalate) ("Dacron"), and polyester resins used in glass-reinforced plastic laminates.

In addition to the increased applications of these conventional techniques of polymer synthesis, entirely new polymerization reactions have been discovered, developed, and commercialized, leading, for example, to epoxy resins, polyurethane foams and elastomers, polyoxymethylene, and polycarbonates, whose properties and applications are yet to be fully exploited. Perhaps the greatest triumph of syn-

thetic polymer chemistry in recent years has been the discovery of a new family of catalysts for vinyl polymer synthesis which yields chain polymers of amazingly high structural regularity. By this means, it has been possible to create "stereospecific" polymers with extraordinary mechanical strength and thermal stability, using inexpensive starting materials, such as propylene, which have heretofore been useless as polymer intermediates. These catalysts have also led to new routes for the manufacture of "synthetic natural rubber"—the culmination of a challenge which thwarted synthetic chemists for the better part of a century.

The recent rapid advances in the study and control of polymer structure have brought to light striking similarities between polymers and other important materials such as metals, ceramics, and glasses. Recognition of these similarities has made polymer science and engineering exemplary of a trend in modern technology which is having an important impact upon scientific thought and educational practices.

In its formative years, polymer science was regarded as the restricted domain of the physical and synthetic organic chemists. As the unique properties and potential utility of polymers became better appreciated, specialists in ever more diverse branches of science and engineering became interested in them as subjects for careful study. Today, polymer science is so broadly interdisciplinary in scope as to defy identification with any one technological specialty: physicists study polymer microstructure; structural organic chemists and quantum mechanicists attempt to unravel the mysteries of stereoregular polymerization mechanisms; electrical engineers examine the dielectric properties of polymers; mechanical engineers explore stress-strain and failure-phenomena; solid-state physicists investigate transitions and semiconductivity; biophysicists and biochemists seek, in the study of polymerization mechanisms and polymer structure, the origins of heredity in living systems, and the source of the life process itself.

From rather inauspicious beginnings, the science of polymers has thus developed in the brief span of 40 years into a major field of scientific endeavor, utilizing virtually all the skills of today's technology. The far broader area of materials science and engineering, of which polymer science is but a small fragment, presents an opportunity for interdisciplinary activity which can hardly fail to lead to major scientific and practical achievements. M.I.T., with its diversified scientific and engineering interests, has been quick to recognize its unique ability to exploit this opportunity, and is well along the road toward the establishment of a trans-departmental teaching and research program in materials. This program promises to be a noteworthy feature of M.I.T.'s Second Century objectives.

Objects and Plan

OF AN

INSTITUTE OF TECHNOLOGY;

INCLUDING

A SOCIETY OF ARTS, A MUSEUM OF ARTS, AND A SCHOOL OF INDUSTRIAL SCIENCE.

PROPOSED TO BE ESTABLISHED IN BOSTON.

Prepared by Direction of the Committee of Associated Institutions of Science and Arts;

AND ADDRESSED TO

MANUFACTURERS, MERCHANTS, MECHANICS, AGRICULTURISTS, AND OTHER FRIENDS OF ENLIGHTENED INDUSTRY IN THE COMMONWEALTH.

BOSTON:
PRINTED BY JOHN WILSON AND SON,
22, School Street.
1860.

IN THIS, one of the first pieces of printed matter regarding M.I.T., William B. Rogers and others responsible for founding the Institute called for "the most earnest cooperation of intelligent culture with industrial pursuits" and said "the subject of Applied Chemistry would . . . claim an important place in the plan of instruction proposed here."

Books

THE UNIVERSE AT LARGE, by Hermann Bondi; Doubleday & Company, Inc., (95 cents). *Reviewed by Harlow Shapley, Harvard's distinguished astronomer and Life Member of the M.I.T. Corporation.*

IN SELECTING this small book by Hermann Bondi, the Physical Science Study Committee has definitely succeeded in its aim of helping to "provide a survey of physics within the grasp of the young student or layman." Some readers may have wished to hear less of Olber's Paradox and the tides, and more about Mars and the Moon, and at least a mention of extraterrestrial life; but they can't have everything in 150 pages.

It is refreshing to see an astronomical surveyor start off with four chapters on galaxies rather than the usual routine overemphasis on the rather trivial solar system (cosmically speaking). And we welcome the practical common sense that Bondi shows and encourages when he warns of the tentative nature of many of our pretty scientific theories and the scantiness of our cosmographic observations.

"It is not the purpose of any scientific theory," wisely remarks Dr. Bondi, "to be infallible or final or true. Its purpose is to be fertile; to suggest new observations that suggest new ramifications of the subject."

These 12 chapters are reprinted from *The Illustrated London News*. If they had been written especially for the committee there would probably have been fewer slips and fewer incomplete presentations; but the slips are not serious.

The "big bang" and the "steady state" cosmogonies are fairly presented, and the vulnerabilities of both are pointed out. We are still a long way from knowing much about origins and destinies in the sidereal world.

MICHELSON AND THE SPEED OF LIGHT, by Bernard Jaffe; Doubleday, Anchor (95 cents). *Reviewed by Ralph D. Bennett, former Professor of Electrical Measurements at M.I.T., who is now Director of Research, The Martin Company, Baltimore, Md.*

I HAVE read Bernard Jaffe's splendid story on *Michelson and the Speed of Light* with much pleasure. It was my good fortune to be a student of Dr. Michelson's in the early 1920's, when I had his courses in wave motion and physical optics. At that time he was America's outstanding physicist and a man of great dignity and imposing bearing. He held forth in frock coat and wing collar at 11 on Mondays and Wednesdays, and then quizzed us orally at 11 on Fridays. Sometimes we failed to understand all the steps in his derivations, which led to long hours of discussion, and sometimes reproduction from memory, if not from understanding, at the blackboard on Friday.

Mr. Jaffe has faithfully depicted Michelson's complete absorption with science, and relative indifference to people. I doubt if he knew the members of his classes well enough to be sure which person was associated with which name on the class roll. We never felt sure we were recognized when we spoke to him respectfully on meeting him in the halls of Ryerson Laboratory. And, by my time, he had long since foregone graduate students, leaving these to Gale, Lemon, and others.

From Mt. Wilson and Palomar Observatories

A 200-inch photograph of a barred spiral nebula in Pegasus.

In my association with the University of Chicago, I had the opportunity to see much of Michelson's famous equipment. I was led into the Ryerson basement holy of holies by Fred Pearson to see the ruling engine that made the "perfect" 8-inch grating (the thermostat was reputed to have stuck!), and one of my colleagues used the 10-inch grating in his thesis—both accurately described by Jaffe. I visited the Clearing, Ill., setup for his last ether drift test—a very long streetcar ride into the prairies then. The Mount Wilson-Mount Baldy light velocity experiment was still active when I visited Mount Wilson in the mid-1920's. The star diameter interferometer was there too, and later I also saw the Irvine Ranch experiment for measuring light velocity in a vacuum. Mr. Jaffe has depicted all these accurately as I recall seeing them when I was a young physicist.

Finally, it was my good luck to be present at the dedication of the Michelson Laboratory at China Lake, Calif., on which occasion John Nicholas Brown, Secretary of the Navy, Robert Millikan of Cal Tech, and Beatrice Michelson Foster were the principal speakers. Mr. Jaffe has performed a service in calling attention to the existence of this collection of Michelsoniana and its availability to the interested public.

The importance of a biography such as that of Michelson by Jaffe is great. The first half of our century produced heroic figures in science at a time when a man could conceive and carry out, with a couple of skilled assistants and a few thousand dollars, an experiment which could reshape the whole world of physics. These stalwarts were an inspiration to my generation, and should continue to be to the young people now growing up. Some of these young people may be encouraged to turn to science because of such portrayals of the lives and works of these great men.

(Book news is concluded on page 48)

Psychology's New Status at M.I.T.

A graduate curriculum and research program is being devised in this rapidly growing science

BY ROGER BROWN
Associate Professor of Social Psychology

WORK in psychology at M.I.T. is being strengthened now as recommended last June by a Committee on the Social Sciences headed by Max Millikan, Professor of Economics. In this article, Professor Roger Brown (who is pictured at the right) explains why and how psychologists have become important participants in the Institute's educational and research programs and reviews the growth of this science.

Professor Brown is especially interested in language and communication. He came to M.I.T. in 1957 after teaching at Harvard and the University of Michigan. He is a member of the Behavior Science Section of the National Institue of Mental Health and his recent book, "Words and Things," was a selection of both the Basic Books Club and the Library of Science Book Club.

ONE of the uses of psychology in an institute of science and engineering was demonstrated in a recent television program. This *Tomorrow* program, telecast in connection with M.I.T.'s Centennial, was entitled "The Thinking Machine," and dealt with the development, the uses, and the future of computers.

People are interested in doing two kinds of things with the high-speed digital computers now available: Some are trying to program these machines to get answers to problems in the most efficient manner possible. Efforts also are being made to program the machines to get answers to problems in the same way that human beings do.

The human way is not always the quickest or surest way. It is worth while, nevertheless, to simulate the external aspects of human intellectual performance because, when the simulation is good, the internal information processing may be the same in both cases even though the respective hardware and software are quite different. Since the precise description of regularities in human performance is the business of psychology, this science is the indispensable partner of electronic simulation and neurology in the lofty enterprise of figuring out how the human brain works.

Our Roles in Groups

M.I.T. has long been concerned both with the advancement of knowledge and with its applications, and since 1952 has had a School of Industrial Management as well as schools of science and engineering. Industrial management is primarily concerned with accomplishing business objectives by means of human instrumentalities. The Faculty concerned with training men for management necessarily, therefore, takes a lively interest in the work of social psychology. Consider the following questions:

¶ Under what circumstances is the small problem-solving group successful in accomplishing its tasks and in gratifying its membership?

¶ Is it possible that the successful group passes through a regular set of phases and produces certain essential types of leadership?

¶ Is it furthermore possible that successful groups require the participation of certain kinds of personalities; that one might write a recipe of the human ingredients required for effective group functioning?

These are questions that have been studied by systematic experiments. In one procedure, six or seven men are called together to work out a solution to a hypothetical problem in human relations. While they work at the problem, they are unobtrusively observed by a research team that codes their interactions into a dozen content categories, such as:

"Gives suggestion,"	"Shows tension release,"
"Agrees,"	"Asks for opinion."

A gradual differentiation of roles is revealed by the tendency of one man to specialize in pushing toward problem solution (the Idea Man), while another specializes in taking care of the social-emotional needs of the participants (the Best-Liked Man).

Naturally, the School of Industrial Management at M.I.T. and the Industrial Relations Section in the Department of Economics are intensely interested in this kind of work, and also in the current studies of what is called the Achievement Motive, various studies of behavior in organizations, and of the determinants of changes in attitude.

Wherever You Look

There are now about 30 psychologists at M.I.T. They are in the Research Laboratory of Electronics, at Lincoln Laboratory, in the Center for International Studies, in the School of Industrial Management, and in the Department of Economics and Social Science. Furthermore, M.I.T. has long been a distinguished name in psychology because of such work as the studies of group dynamics by Kurt Lewin and Alexander Bavelas, '48, and the pioneering application of the mathematical theory of information to human behavior by

George Miller and J. C. R. Licklider. One of the most popular undergraduate options in the School of Humanities and Social Science is the psychology sequence offering students an opportunity to study such topics as Motivation, Learning, Perception, Language, Theory of Personality, and Social Psychology.

In view of all this past and present activity, it may seem surprising that the June, 1960, report of the Committee on the Social Sciences called for the creation of a distinguished psychology unit at the Institute. There was something important to call for, however, and the committee recognized it by asking that the "highest priority" be given to the proper establishment of psychology as one of the Institute's fields of interest. Having psychologists perform service functions for a variety of research centers and teach a few undergraduate courses is not enough. Research psychologists want to train graduate students, so a doctoral program is needed. Although some developments in psychology are immediately useful to established nonpsychological units at the Institute, other highly promising developments are not. To make sure that the best things are recognized and developed at M.I.T., an independent psychology unit is needed. M.I.T. clearly can make a distinctive and important contribution to psychology itself, and this is something we owe to our society.

President Stratton's response to the call from the Committee on the Social Sciences was both prompt and appropriate: He appointed Professor Hans-Lukas Teuber, an eminent student of the brain and behavior, to head an expanded Psychology Section. Professor Teuber comes to M.I.T. from New York University and the N.Y.U.-Bellevue Medical Center, and his appointment, as President Stratton has said, "marks the serious entry of psychology as a behavioral science at M.I.T." Under his leadership, psychologists at the Institute now are devising a graduate curriculum and research program.

The Growth of Psychology

The extraordinary thing about psychology is its enormous subject-matter range: from near-physiology to near-sociology and near-psychiatry. If a Committee on the Natural Sciences had been at work last year, it quite likely would have called, as did the Committee on Social Sciences, for an independent psychology unit at M.I.T.

The systematic study of human behavior developed a number of growing points during the second half of the Nineteenth Century and the early years of this century. One of these growing points was in the physiology of the sense organs, and such men as Hermann von Helmholtz can be numbered among the first psychologists.

Hermann Ebbinghaus began the study of human learning by serving as his own subject in the rote memorization of nonsense syllables. Sir Francis Galton devised a method for studying the associative processes, the technique of word-association, and, in later years, Pavlov developed a very general method to a similar end—the conditioning of reflexes.

Edward Thorndike began his studies of trial-and-error learning by putting a cat in a box from which it could escape by learning to operate the latch. In 1905 the school authorities of Paris set Alfred Binet the problem of devising a test that would identify school children whose intelligence was so low that they could not profit from attending school, and the result was

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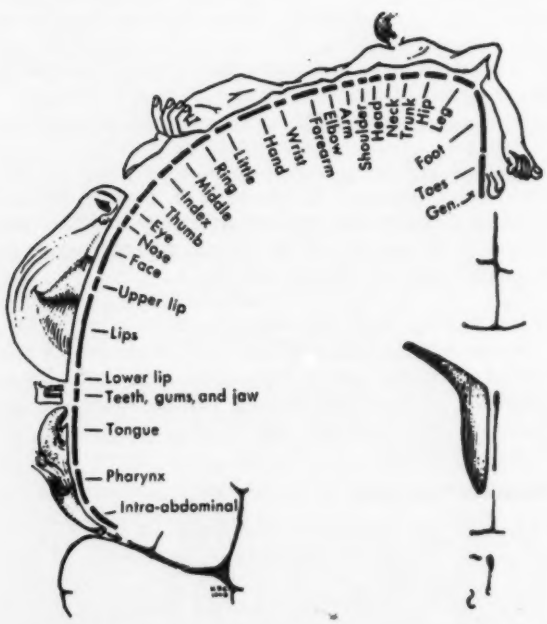
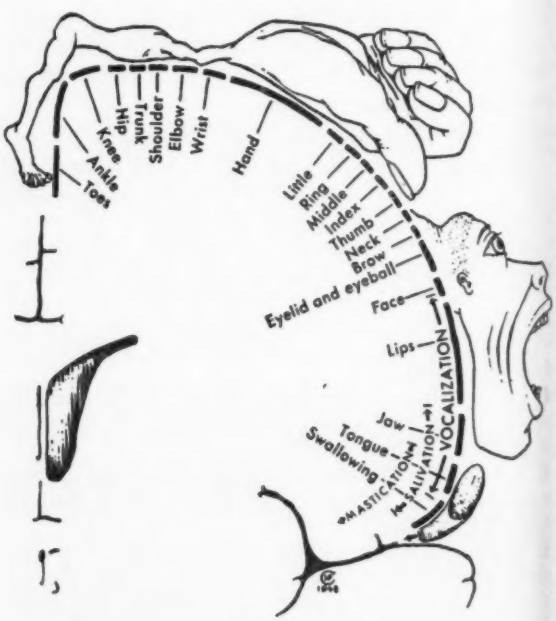


SENSORY HOMUNCULUS: This is the topographical arrangement of the sensory area which is in general concerned with sensations from the skin. The relative sizes of the areas representing different regions of the body correspond to the fineness of discrimination possible for those regions.



MOTOR HOMUNCULUS: The motor area of the cerebral cortex is in general concerned with skilled movement. This drawing indicates its topographical arrangement. The relative sizes of the areas representing different parts of the body correspond to the relative dexterity of those parts.

Institute Yesteryears

25 Years Ago . . .

PROFESSOR DAVIS R. DEWEY, Head of the Department of Economics, contributed his views upon the current depression to The Review in part as follows:

"Economic depressions have their compensations, for at least we can see economic laws working to completeness. They do not have to be reviewed by a supreme court. It is not often that the economist has such a well-equipped laboratory at his disposal. . . .

"No discussion of economics is complete nowadays without some reference to the New Deal. I dislike the term 'New Deal.' It savors too much of a game of idle amusement in which chance plays a considerable role. I should prefer 'New Plan,' and I have hoped for a New Plan long before the present depression set in. However, if we must talk about the New Deal, let us use the language of the card player.

"Much of the present New Deal is wrongly named; it is an Old Deal, based on rules which economics junked years ago. If we are to have a New Deal, let us have the cards played by those who know the rules. As yet neither party has emerged from the rules of Victorian whist; it is time to bring the rules down to date.

"This is an age of contract and big and little slams and disastrous penalties for getting set. Revoking is too common, and too frequently the player trumps his partner's ace. We need to pray for . . . a bridge mastermind, and the kibitzers should not crowd the players. Psychic bids should be rigidly shunned.

"Some of us think that playing the Deal according to sound economic rules might not only restore prosperity, but lead to a continuous abundance whereby the standard of living will ever be raised."

¶ Professor *Harold K. Barrows, '95,* was elected President of the Boston Society of Civil Engineers, and *Richard S. Holmgren, '19,* received that society's Clemens Herschel Award.

50 Years Ago . . .

IN THE Boston *Herald* of March 10, 1911, there appeared an account of an interview with President Richard C. Maclaurin concerning the Institute's proposed removal from the Copley Square area. Said the *Herald:*

"A feeling against moving away from Boston and the problem of taxation of college property in Cambridge are two reasons against moving Technology to Cambridge, in the opinion of President Maclaurin. It is known that among the sites now under consideration by the Executive Committee of the Institute's Corporation two or three are in Cambridge. . . ."

¶ President Maclaurin's statement on the Cambridge location, as quoted by the *Herald,* was:

"The advisability of our going to Cambridge is being urged upon Technology from a large number of sources. Invitations have been received from the mayor of Cambridge, the Cambridge Taxpayers' Association, Cambridge Club, Citizens' Trade Association, and many prominent business and educational men of the city.

"I have also received numerous petitions from the people of Cambridge asking for favorable consideration to locate the Institute on land bordering on the Charles River esplanade. There are many sites bordering on the Charles River and a number of them offered us have many attractions from the point of accessibility and expansion. Some of this land can be obtained at a very reasonable price.

"The objections to going to Cambridge mainly refer, first, to moving the Institute away from Boston, and secondly, to taxation of college property.

"Technology has been associated throughout its history with the city of Boston and there is a strong feeling that the school of applied science should continue in that association.

"There has apparently been much unrest in Cambridge by a certain few people at having so much property in the city exempt from taxation. From this alone there might be serious objection to increasing the amount of property which would come outside the taxable list.

"If the Greater Boston plan should go through, the first objection would be removed, and no one can doubt that the Institute going to Cambridge and locating on the water front would greatly add to the wealth of the city and save the Charles River esplanade from being occupied by manufacturing plants and other commercial structures."

75 Years Ago . . .

THE CLASS OF 1887, reported *The Tech,* "having learned that 'capital arises solely out of savings,' has taken initiatory steps toward the formation of a co-operative society. Societies similar to the one proposed flourish at Harvard and Yale, and the students at such a practical and progressive place as the Institute should be quick to appreciate the advantages to be derived from such an organization."

¶ And in an adjoining column, it was noted: "A bicycle club has been formed at the Institute. Its membership is already large. Two very successful runs have been held. . . . It is said that a large number of '87 men witnessed the eclipse of the moon on the night before the condition examination in physics."

86 Years Ago . . .

ON MARCH 17, 1875, in the Institute building at 491 Boylston Street, Boston, there assembled 23 graduates at 7:00 P.M. for the express purpose of perfecting the organization of the Alumni Association of M.I.T.

100 Years Ago . . .

ON MARCH 19, 1861, the Joint Standing Committee on Education of the General Court of the Commonwealth favorably reported a bill for the incorporation of the Massachusetts Institute of Technology. On March 25, the bill was ordered to be engrossed by the House; and on March 29, the same action was taken by the Senate.

M.I.T. Athletes Are Successful in Winter Sports

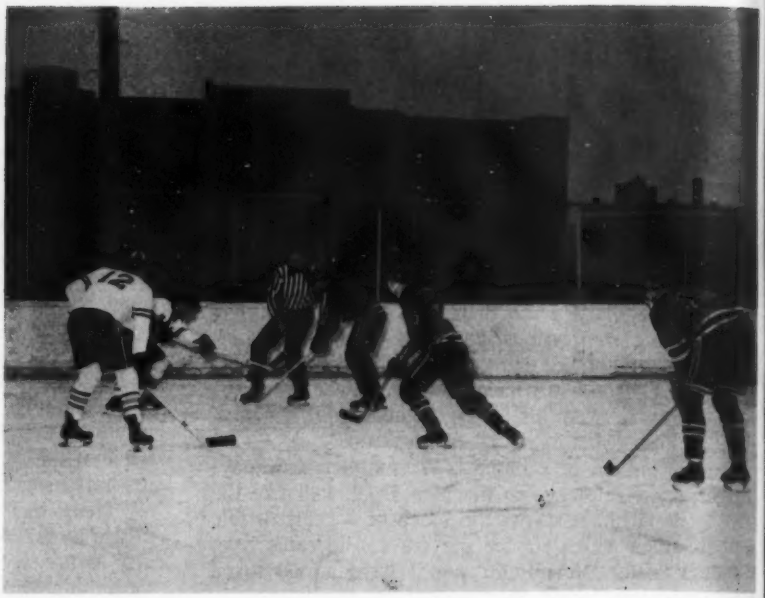
MID-TERM exams at M.I.T. this year found the intercollegiate athletes with satisfactory records.

Coach Jack Barry's Basketball Team had won three straight games and had a 5-5 record when it left on February 1 for a four-day, three-game road trip. Dave Koch, '62, had averaged 22.4 points a game and appeared destined for "All" honors in Boston and possibly New England.

The Rifle Team was probably New England's "hottest" squad. It had eight victories behind it on February 1, and had only been defeated once—by the U.S. Naval Academy. The score: Navy 1441; M.I.T. 1428.

The Varsity Wrestling Team was unbeaten. Its mid-term record was four victories and two ties, and Coach Alex Sotir expected his matmen to continue their winning ways. Springfield College was considered the only serious threat ahead.

The Hockey Team surprised nearly everyone except Coach Ben Martin, who had predicted a good season. As of February 1, his hard-skating well-conditioned team had won four times and lost only twice. One victory was over W.P.I. by a whopping 11-to-0 score.



By February 1, the Hockey Team had four victories and only two defeats.

Swimming Coach Charlie Batterman spent part of his Christmas vacation in the hospital, having both knees operated on. His Swimming Team had won four victories and experienced one loss to date, and a couple of excellent freshmen were churning up and down the Alumni Pool to encourage him.

Indoor trackmen were less fortunate; they finished last in three meets. The Pistol Team had faced tough competition and lost most of its matches, and the Squash Team had won only one of eight contests. The fencers were about .500 at the halfway point.

James Y. Tang, '63, of Hong Kong is M.I.T.'s star soccer player.

David H. and William I. Koch, both '62, and sons of Fred C. Koch, '22, have been key men on the basketball squad.

Rifle Capt. William L. Leffler, '61 (left), with Coach Ireland, Richard M. Harris, '63, and Ronald J. Pellar, '61.

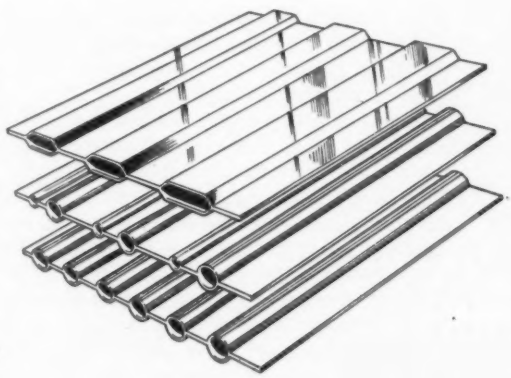
BUSINESS IN MOTION

To our Colleagues in American Business . . .

When Tube-In-Strip* was announced in January, 1956, Revere engineers felt that it would have many varied uses but they never dreamed that those uses would prove as diversified as time has shown them to be.

Since the introduction of Tube-In-Strip, designers and engineers in some 64 basic industries, representing thousands of applications, have been applying this versatile product in the solution of specific problems, the improvement of existing products, and the development of new products. To give you some idea of what can be done with Tube-In-Strip, we cite the following examples:

As a Heat Reclaimer in an industrial laundry, Revere Tube-In-Strip saved $1,485.37 in a four-month period. During that time 200,000 more pounds of laundry were washed than in the previous four months, at a $100 saving in steam cost. Prior to that time, due to a limit on the amount of steam that could be purchased, the laundry had to use lower water temperatures and operate on a two-shift basis. The heat reclaimer consists of a battery of 30 panels, with 3 panels of Revere Copper Tube-In-Strip, riveted together, measuring 48"x82" overall. The unit reclaims heat from the used wash water and uses it to heat the incoming fresh water. This is done by channeling the used wash water around the Tube-In-Strip panels while the incoming fresh water is heated as it flows through the tubes. The savings in steam costs arises from the fact that incoming fresh water does not have to be heated nearly as much to bring it up to washing temperature.



As a Reflective Radiant Cooling Unit in a bakery, Revere Copper Tube-In-Strip saves up to 30% in production while vastly improving product quality. The radiant cooling unit which is used to set chocolate-coated cookies and biscuits, consists of a 108'-long tunnel, fully enclosed. On top and bottom of the tunnel are nine 8' sections of Revere Copper Tube-In-Strip through which is pumped a cooling medium at 8 to 12 degrees F.

Through cooling radiation, this properly sets the chocolate within 4¼ to 5 minutes. A drying unit is also included in the installation, where 250 cu. ft. of super-dry air per minute are forced between plates of Revere Copper Tube-In-Strip at a temperature below zero.

As Water-Cooled Bus Bar Revere Copper Tube-In-Strip makes possible substantial savings in the manufacture of semiconductor rectifiers for a leading electrical product manufacturer. It eliminates the possibility of leaks, results in more efficient cooling, enables the user to change cells without draining the system which is completely sealed, thus eliminating the need for O-rings or gaskets.

As an Electric Heat Fin Element Revere Aluminum Tube-In-Strip is used to heat homes with electric baseboard. The manufacturer who replaced former units with this versatile product reports increased efficiency and simplification of design of heating elements, lower case temperatures and substantial savings in manufacturing costs.

These are just four of the thousands of ways Revere Tube-In-Strip, of copper, copper-base alloys, aluminum and aluminum alloys, can save money . . . improve product quality.

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The Centennial Conference

(Continued from page 13)

and by graduate education? Is there danger that the solution of trying to make everyone "fundamental" may result in an insufficient supply of "doers"? Should some students be trained as practitioners of the art and others for frontier research and development? What about the role and education of the technician?

A great concern is felt because so much of the support of science and technology comes from the military and is therefore biased. Is this true? Is it bad?

It is sometimes claimed that the engineer does not extend his vision to the large social and cultural problems of society. Is this true, and if so, what can or should be done about it? How should the educational system be connected to social needs? Should any special efforts be made to guide students in their choice of fields of study to improve the balance between selection of career fields and the needs of the society?

Interactions of Science, Engineering, and Society: Given a world in which science and engineering will inevitably play such a large part, what measures are to be taken so that citizens can steer technology instead of having it steer them? The problem has at least two prongs.

One of the theories of a good society is that the citizenry shall be able to judge issues wisely, that it be sufficiently informed about them to judge without aid, or sufficiently intelligent about them to distinguish between the claims of partisanship. Has the complexity of the modern world made this original theory obsolete? If so, what are the alternatives? If it is not so, how are the lay citizens to be adequately educated so that they may comprehend economic and other technical issues; and particularly scientific and engineering issues? Can these be explained to citizens who are educated as we now are? Could they be explained if the education of citizens were different? Has this any bearing on other questions besides those of participative citizenship—philosophical, for example? In short, what do laymen need to know about science and its applications? And how can they be taught this as they go through present types of education, in school, in college, in the processes of adult education?

On the other hand, there are questions concerning the education of the scientists and engineers themselves in the areas which are not scientific. Do their new responsibilities of a managerial and political sort find them in any serious way unprepared by their education? Are they any more naïve than anyone else in matters of social or political conduct? Can they learn anything useful from formal exposure to the disciplines that study such matters? Or must they learn what they need to learn only through experience? Engineering education has taken the position that something must be attempted along these lines and thus curricula have contained subject matter in the humanities and the social sciences. Has this really been meaningful? Could it become so?

In the end, both questions merge in the large question of how the most educated members of society who are the specialists of all sorts can find it possible any longer to communicate with each other and whether any

(Continued on page 34)

Richard S. Leghorn, '39

Martin Deutsch, '37

Walter A. Rosenblith

Max F. Millikan

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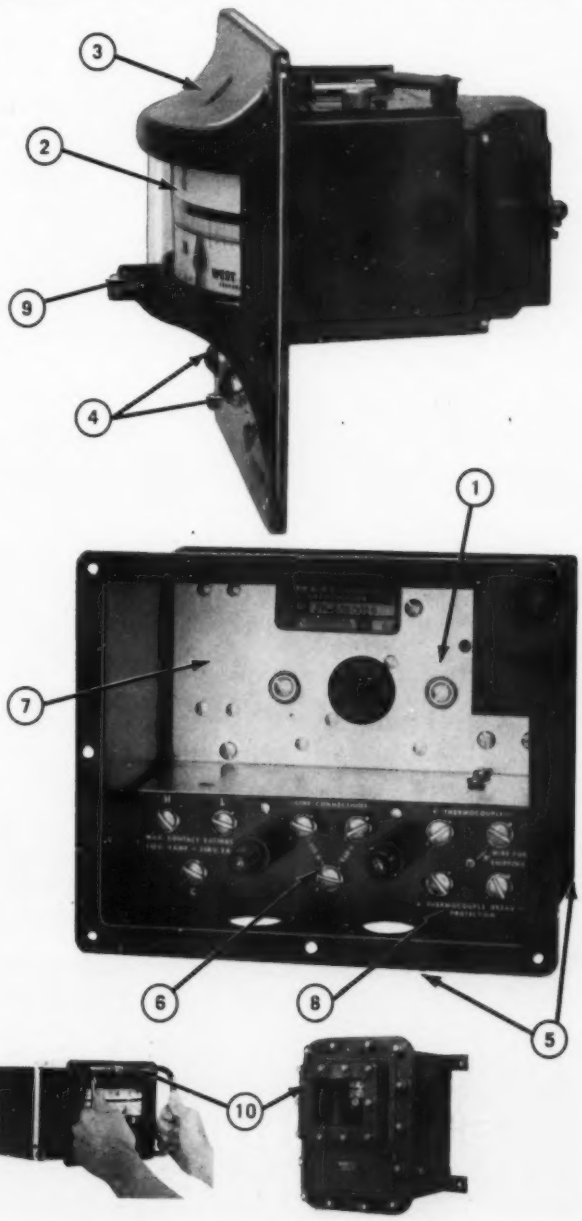

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Richard P. Feynman, '39

Francis L. Friedman, '49

The Centennial Conference

(Continued from page 32)

formal measures of curricular or university organization can in fact improve the present situation.

Implications of Science and Engineering for International Relations: The essential base for a modern society is the application of science by engineering, medicine, and the like. The applications are not amoral. They can be directed to increase the material well-being of peoples: they may also be employed to create more efficient armaments which, in the complexities of competition between nations, have potentialities for universal destruction. The policies of governments are therefore increasingly dependent upon technical possibilities which are available to them.

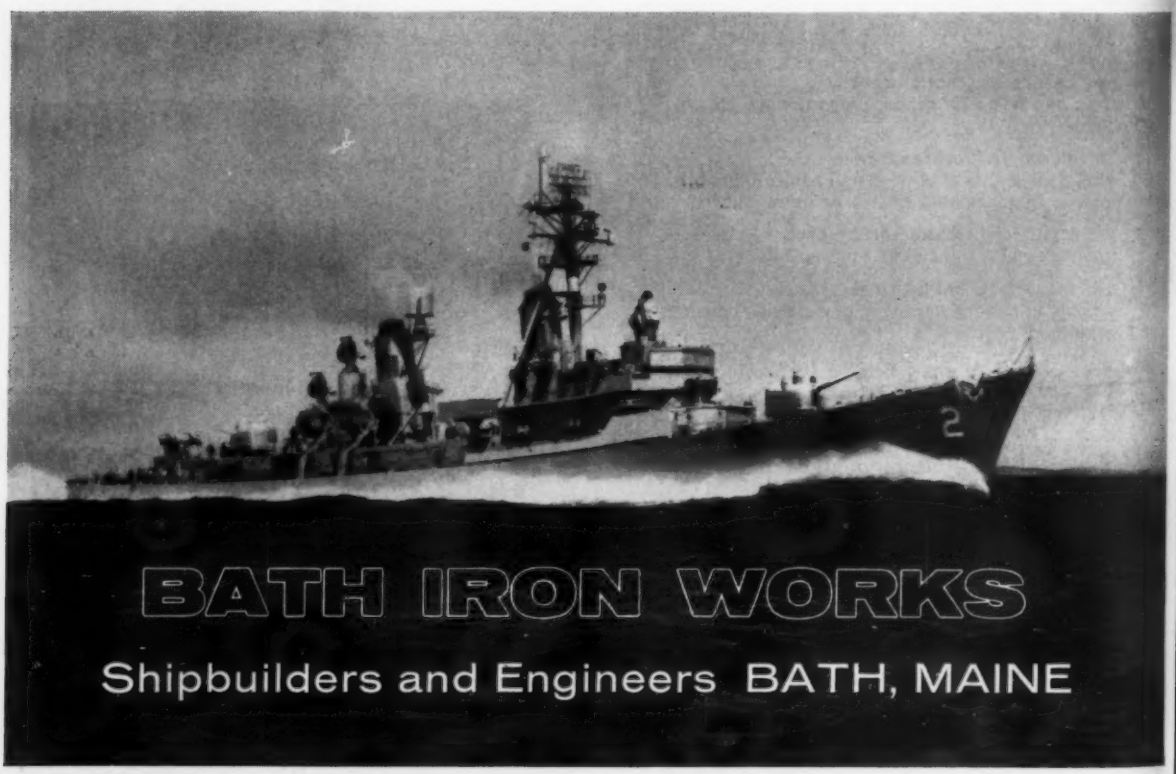
Clearly, as societies become more interdependent, an increasing number of bases for world loyalty and identification, as opposed to national loyalty and identification, may be imperative. If this be true, radically new criteria as to the responsibilities of governments must be developed and accepted, initially by peoples of the technically advanced areas but ultimately by all. Regardless of the validity of these particular conclusions, they suggest many avenues for fruitful exploration.

What are the implications for education of the extent to which technological progress is increasingly influencing the course of international relations and the evolution of societies? What are the responsibilities of scientists and engineers to understand the impact of technical developments on political forces? How can

(Concluded on page 36)

Gordon S. Brown, '31

Jerrold R. Zacharias



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New Books from the M.I.T. Press

Carl Becker: A Biographical Study in American Intellectual History
By Burleigh T. Wilkins

An intellectual biography of a famous historian, this book presents the many phases of Becker's life—from Iowa farm boy to Professor of History at Cornell University and President of the American Historical Association. This study gives valuable insights into the evolution of the American historical profession during the 20th century. *$5.50*

Housing and Economic Progress: A Study of the Housing Experiences of Boston's Middle-Income Families
By Lloyd Rodwin

Boston, an old city with adequate records, is the subject of this statistical study of rising income and the effects on middle-income housing conditions in the past century, including expenditure patterns, rent levels, standards, landuse patterns, middle-income housing movements, tenure issues, and theory of residential growth and structure. *$7.50*

International Education in Physics
By Sanborn C. Brown and Norman Clarke

Proceedings of the International Conference on Physics Education held in the UNESCO House in Paris in 1960 under the auspices of the International Union of Pure and Applied Physics. The book contains formal resolutions, papers, and lists of modern teaching aids for the improvement of physics teaching around the world. *$4.50*

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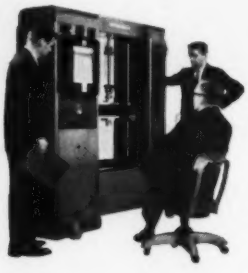

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HAROLD HINDMAN '39 II GEORGE S. BURR '41 VIII

The Centennial Conference

(Concluded from page 34)

technology be fruitfully applied to the solution of international problems? How can scientists and engineers contribute to world understanding and cooperation? What kinds of professional associations between societies at different stages of economic development are most constructive? What are the lessons of the UN Atoms-for-Peace conferences, the International Geophysical Year, CERN, and other such enterprises?

Authors of Background Papers

BACKGROUND papers to be discussed at the International Conference are being prepared by the following:

On Scientific and Engineering Education in Newly Developing Countries: **P. M. S. Blackett,** 1948 Nobel prize winner in physics and Professor of Physics, Imperial College of Science and Technology, University of London; **W. Arthur Lewis,** Principal, University College of the West Indies, and former economic adviser to the government of Ghana; **Robert S. Morison,** Director, Medical and Natural Sciences, The Rockefeller Foundation; **Eni Njoku,** Professor of Botany, University College, Ibadan, Nigeria; **Jerrold R. Zacharias,** Professor of Physics, M.I.T., and member of the President's Science Advisory Committee; **D. S. Kothari,** Professor of Physics, Delhi University, India.

On Scientific and Engineering Education in Countries with More Advanced Technologies: **Gordon S. Brown,** '31, Dean, School of Engineering, M.I.T.; **H. D. G. Casimir,** Professor, Director, Chairman of the Board, Nuclear Energy Division, Royal Institute of Engineers, The Netherlands; **Francis L. Friedman,** '49, Professor of Physics, M.I.T.; **Willis Jackson,** Director of Research and Education, Associated Electrical Industries, Manchester, England; **V. A. Kirillin,** member of Soviet Academy of Sciences; **Shun-Ichi Uchida,** President, Tokyo Engineering College, Japan.

On Interactions of Science, Engineering, and Society: **Raymond Aron,** Professor of Political Science, Sorbonne, Paris; **Eric Ashby,** former President and Vice-Chancellor, The Queen's University, Belfast, and Master of Clare College, Cambridge; **Lucio Costa,** Brazilian architect who designed the city of Brazilia; **Aldous Huxley,** Visiting Professor of Humanities, M.I.T.; **Humayun Kabir,** Minister for Scientific Research and Cultural Affairs, India; **Adam Schaff,** member, Polish Academy of Science, Professor of Linguistics, University of Warsaw, Poland; **A. V. Topchiev,** Vice-president, Soviet Academy of Sciences.

On Implications of Science and Engineering for International Relations: **Pierre Auger,** Chairman, French Committee for Space Research, and former Director, Department of Natural Sciences, UNESCO; **Lloyd V. Berkner,** President, Graduate Research Center, Southern Methodist University, and former member, President's Science Advisory Committee; **Homi J. Bhabha,** Director, Tata Institute of Fundamental Research, Bombay, and Chairman, Atomic Energy Commission, India; **George Brock Chisholm,** Director General of World Health Organization; **Isidor I. Rabi,** 1944 Nobel prize winner in physics, Professor of Physics, Columbia University, and member of the President's Science Advisory Committee.

Don Rasmussen (left), owner of the DHRCO Distributing Company, discusses his new insurance program with New England Life representative Reese Allen.

Agent's advice brings $125,000 sale —opens door to additional service

Reese Allen enjoys working with top-level businessmen like Don Rasmussen. Not long ago, Reese established a $125,000 insurance program for him. Mr. Rasmussen, obviously pleased with the plan, has asked Reese to meet with his attorney and assist in setting up a corporation with a buy and sell agreement and related insurance program.

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Arms Control

(Concluded from page 16)

to go down to zero, you could come to a very dangerous situation for the fellow who was playing the game squarely—where he might have no force available and be faced by a hidden stockpile.

It has been our contention that if one not only made a declaration and turned over weapons to the control authorities on some schedule, but also allowed completely free access for inspection to build up while the stockpile was being reduced, the error that could exist at any given time would get smaller and smaller. So the permitted safe limits would be considerably smaller.

RICH: What I found a little bit encouraging was their willingness to say it seems reasonable to them to couple the degree of inspection to the degree of disarmament.

WIESNER: We would like a lot of inspection before we do very much disarming, and they would like a devil of a lot of disarmament before they permit much inspection.

ROSTOW: The homework hasn't been done in the United States, and certainly not in the Soviet Union. There's a whole range of problems involved quite aside from the inspection problem. If you go below a certain level of mutual deterrence, you run into the deep unsolved problems of world order, international unrest. . . .

As I sat there, a nonscientist listening to the scientists talk, I sometimes felt I was in a very hopeful new world and sometimes I felt I was mad. . . . The sense of madness arose because simultaneously with our presence in Moscow there was the summit meeting of the 81 Communist parties, and as we are talking now we have Cuba, Laos, and Congo. . . . I think it's perfectly clear that the equivalent of partial disarmament is the establishment of some new political rules which would govern competitive coexistence. I myself don't think you're going to have any serious disarmament unless the Communists stop shipping arms across the borders of the free world.

LEGHORN: As far as the Soviet scientists are concerned, I became convinced that they want a disarmed world primarily because of their fear of the *n*th country (particularly Germany and China); secondly, because they think they can take over better in a disarmed world through stepped-up nonviolent competition; and thirdly, because they'd like to free up their economic and technical resources so that they can take over better.

But I am not sure how much they represent governmental thinking. . . .

ROSTOW: I see no reason to change my own prior views that we should go on as rapidly as we can to secure a situation where we are not vulnerable to a surprise attack. . . . With respect to the underdeveloped areas, my feeling of urgency about building nonmilitary connections was simply increased. . . . I don't think any of us, from the evidence we have, can assess the weight within total Soviet policy of the strand we were privileged to examine. But I think it's the high duty of the next administration to find out what the specific gravity of this element is. There's only one way we are going to be able to find out, which is to develop our own arms control and disarmament plans, with which we can stand up before the world with confidence, and which will permit us to deal with whatever propaganda element there is, and have proposals that we are prepared to live with should they be acceptable.

Jobs Wanted in Small Businesses

GRADUATE STUDENTS in the M.I.T. School of Industrial Management are looking for jobs with small business concerns. Twenty-seven men, averaging 25 years in age, who expect to receive master's degrees in June, have indicated a preference for employment in a small concern rather than a large firm. This is the second year that such students have set up a "Business Search Group." Some of this year's participants are interested in summer employment rather than permanent posts.

Interested employers are urged to write to Business Search Group, Room 52-152, 50 Memorial Drive, M.I.T., Cambridge, Mass.

PHILIP STOCKER AND MARK WHEELER DISCUSS THE NEW SYMBOL THAT REPRESENTS THE PERSONALITY OF THE NEW ENGLAND MERCHANTS NATIONAL BANK

Mr. Stocker and Mr. Wheeler are Senior Vice Presidents of the newly-formed "New England Merchants".

STOCKER: That's quite an array of symbols, isn't it?

WHEELER: It's hard to believe that so many could be designed to express the personality of our Bank.

STOCKER: What's amazing is that all of us were unanimous in choosing the lighthouse.

WHEELER: It seems to sum up so well all the things we wanted to say about ourselves. A lighthouse *is* New England and our symbol says we're a New England regional bank and that we're committed to the future of New England.

STOCKER: I'd also say it symbolizes several other things we stand for: guidance . . . security . . . safety . . . even enlightenment. One of our most important jobs is to shed light on all kinds of money problems.

WHEELER: Yes, and you might add that it stands for our policy of steady help and counsel to our customers.

STOCKER: Now that we've grown in size, this policy grows in depth, doesn't it, in our commercial activities, our Trust Department, and in all our services to the individual customer. And we're planning new *kinds* of service in all these fields.

WHEELER: But we offer all with the same basic idea, the idea of person-to-person banking. That's the key to our Bank's personality and the idea we've tried to capture in our new signature.

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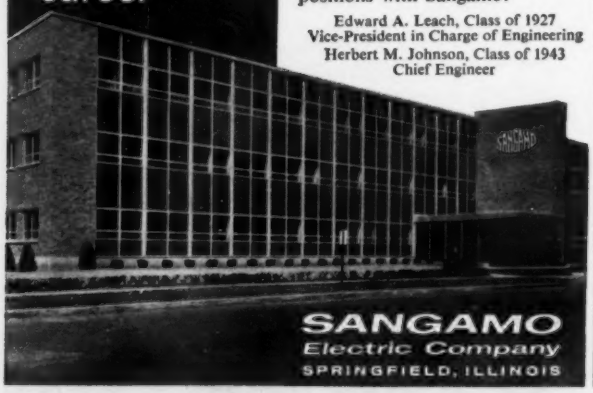


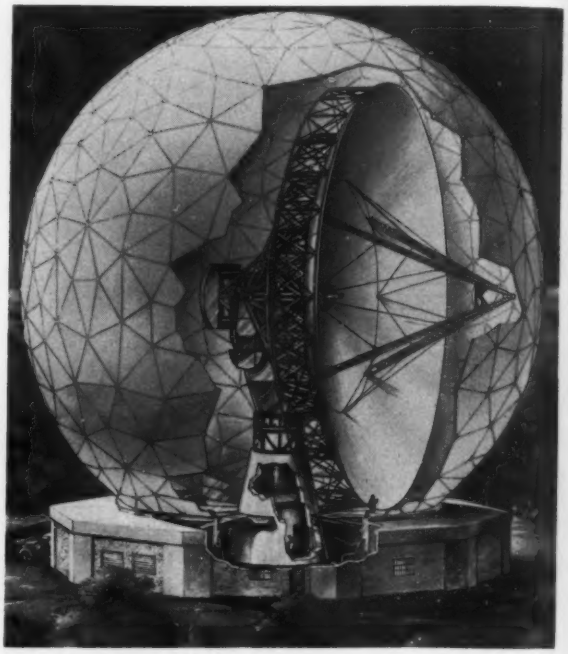
SANGAMO
Electric Company
SPRINGFIELD, ILLINOIS

Trend of Affairs

(Continued from page 39)

The Dome on Haystack Hill

ON HAYSTACK HILL, near Lincoln Laboratory's other big antennas at Westford, Mass., a new and larger "dish" is being erected this year. This precision paraboloid antenna for high-power radio research will be 120 feet in diameter—and the very antithesis of a haystack. Specifications call for holding the parabolic contour to about $\frac{1}{16}$th of an inch over the whole antenna surface in all orientations.



An artist's conception of the edifice in Tyngsboro, Mass.

It will be used to study the characteristics of a global radio communication method on which Lincoln Laboratory has been working for some time,* and be adaptable for research in radio or radar astronomy. It is expected, in fact, to make it possible to detect a metal ball only a quarter of an inch in diameter at a distance of 1,000 miles, and to be helpful in efforts to examine the surface of Venus.

A radome 150 feet in diameter will protect the huge reflector from the wind and sun. This will stand on top of a 10-sided building which will house the main power supply, auxiliary apparatus, and offices. The transmitting and receiving apparatus will be in a box directly behind the feedhorn in the center of the reflector. This 8-by-8-by-10 foot "room" will be capable of holding up to 4,000 pounds of apparatus, and so constructed that it can be unplugged and replaced by a different package of electronic circuitry whenever the operators want to put the antenna to a different use.

Lincoln Laboratory will operate and evaluate this new facility for the Air Force. North American Aviation is building it. Operational testing is scheduled to begin late next year.

* See "Useful Belts in the Sky," Technology Review, November 1960, p. 23.

(Trend of Affairs is concluded on page 42)

Said Johann Kepler: *"The planets move in elliptical orbits about the sun, and the square of their periods of revolution are proportional to the cube of their mean distances from the sun."*

With interplanetary voyages fast becoming a reality, complete information regarding the velocity requirements for travel between planets is of vital importance. With these data available, it is possible to analyze propulsion requirements, plan ultimate system configurations, and conduct feasibility studies for any particular mission.

Lockheed Missiles and Space Division scientists have actually evolved a rapid-calculation method, utilizing a high-speed computer. This has produced literally thousands of orbits, velocity requirements, and elapsed time, for design studies of trips to and from both Mars and Venus—every tenth day from now until January, 1970.

More simple to analyze are many factors which make Lockheed Missiles and Space Division a wonderful place to live and work. Located in Sunnyvale and Palo Alto, California, on the beautiful San Francisco Peninsula, Lockheed is Systems Manager for such programs as the DISCOVERER and MIDAS satellites and the POLARIS FBM. These, together with research and development projects in all disciplines, make possible a wide diversity of positions for creative engineers and scientists in their chosen fields.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-14 G, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

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Trend of Affairs

(Concluded from page 40)

Alumni Council Meeting

AT ITS January meeting in the M.I.T. Faculty Club, the Alumni Council learned that Secretary Donald P. Severance, '38, has been assigned to essentially full-time work as a member of the staff of the Second Century Fund. Frederick G. Lehmann, '51, Assistant Secretary, will take over much of the work for the Association which Mr. Severance has done in the past.

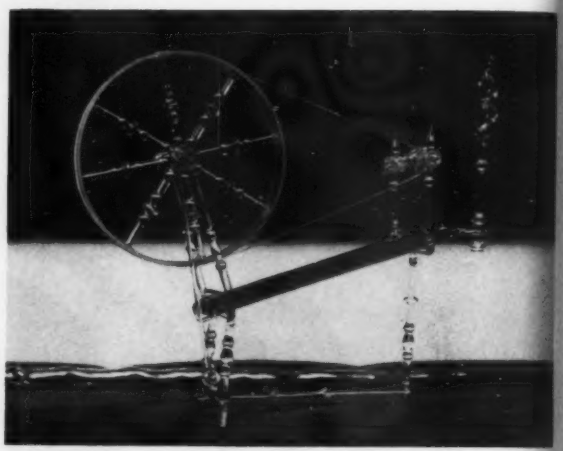
Reports to the Council showed that 9,300 Alumni had contributed to the Alumni Fund prior to this meeting, and 6,717 advanced orders had been received for the new directory of M.I.T. Alumni to be published this spring. *(Details about the new directory are given in the advertisement on page 52.)*

Speakers at this meeting were John I. Mattill, Director of Publications, and David G. Hoag, '46, Assistant Director of the M.I.T. Instrumentation Laboratory. Mr. Mattill showed examples of M.I.T. publications and discussed design problems. Mr. Hoag showed pictures of the Polaris and told about the Instrumentation Laboratory's work on the guidance system for this missile and the nuclear submarines which are being armed with it.

President Clarence L. A. Wynd, '27, presided, and D. Reid Weedon, Jr., '41, announced the Association's plans for the observance of M.I.T.'s Centennial. Members and guests present totaled 195.

The Glass Spinning Wheel

THE CASES in the corridors at M.I.T. contain a vast assortment of things, but few are as eye-catching as a glass spinning wheel on the third floor of Building 2. It was produced by Henry Wayringer, who blew glass for the chemists for many years. Born in Austria, he traveled all over Europe to master his trade. In this country he made ultraviolet-ray lamps for General Electric, and fashioned the first quartz neon lamp used as an airplane beacon, before coming to M.I.T. Now 86, Mr. Wayringer lives in Florida, but his work is still on display.



The Chemistry Department's little glass spinning wheel.

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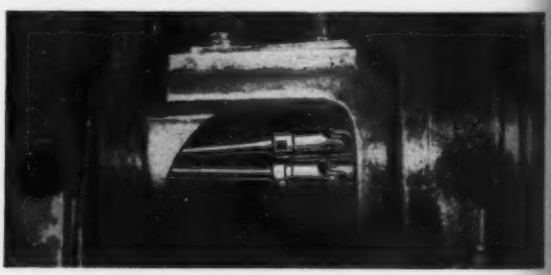
Bridgeport, Connecticut

G. R. WEPPLER '37

Solving a breakage problem AT CLOSE QUARTERS



The manufacturer of this button-drilling machine had a tough problem: the universal joints on these parallel shafts carried such a torque load there were frequent complaints of breakage . . . yet the close centers prohibited use of a larger joint. **The solution** was a Curtis Universal Joint of the same size but higher torque.

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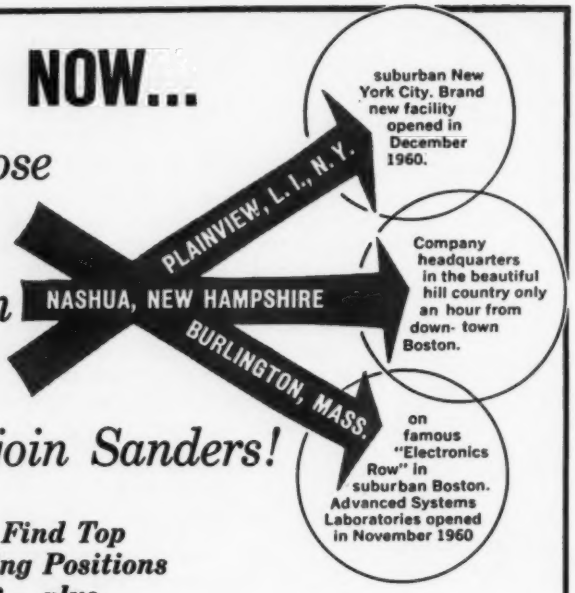
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Company headquarters in the beautiful hill country only an hour from down- town Boston.
on famous "Electronics Row" in suburban Boston. Advanced Systems Laboratories opened in November 1960

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Individuals Noteworthy

(Continued from page 8)

Hazen's New Post

HAROLD L. HAZEN, '24, Dean of the Graduate School, left M.I.T. in January to become interim president of Robert College in Istanbul, Turkey. He will be on leave of absence for the rest of this academic year, to replace Duncan S. Ballantine, a former member of the M.I.T. Faculty, who has resigned from the presidency of Robert College because of ill health. John T. Norton, '18, Professor of Metallurgy, is Acting Dean of the Graduate School in Dr. Hazen's absence.

Robert College is a growing institution which occupies a spectacular site overlooking the Bosporus. Founded in 1865, it is the oldest American college abroad, and has many American and European scholars on its faculty. Students are admitted irrespective of race or religion, intellectual independence and self-reliance are encouraged, and instruction is offered in engineering, science, languages, and business.

Alumni Day Committees

THE FOLLOWING committees to plan the 1961 Alumni Day at M.I.T. have been named by the Association's Executive Committee:

Registration—Wolcott A. Hokanson, G. Edward Nealand, '32, and Robert E. Hewes, '43.

Symposium—Edward O. Vetter, '42, Morris Cohen, '33, Randolph Antonsen, '35, Jay Zeamer, Jr., '40, James O. McDonough, '43, and Donald A. Hurter, '46.

Luncheon—David P. Flood, '45, William H. Carlisle, Jr., '28, Fisher Hills, '29, Philip A. Stoddard, '40, Paul Wing, Jr., '34, and Edwin H. Tebbetts, '46.

Banquet and Evening Entertainment—John L. Danforth, '40, Edward R. Marden, '41, Gerald V. Quinnan, '45, Lloyd D. Brace, Jr., '56, Miles P. Cowen, William Morrison, and Mrs. John W. Chamberlain.

Epoxy Firm Formed

TWO MEN who met at M.I.T. as graduate students have formed a new firm at 238 Main Street in Cambridge, to formulate epoxy resins. Arthur P. Alexander, '58, and Charles F. Langenhagen, Jr., '58,

call their firm Allaco Products, and have developed an epoxy resin that cures in one minute at room temperature. Epoxies are being used now to duplicate foundry patterns and can replace soldering, spot welding, and brazing in some manufacturing processes.

Visiting Architects

Two of the world's most creative designers, Pier Luigi Nervi and Sven Markelius, will be visiting professors of architecture at M.I.T. this spring.

Professor Nervi, who is nearly 70, is noted for his distinctive work with reinforced concrete. He built the two Sports Palaces in Rome that were used for the Olympics last year and the Turin Exhibition Hall, and he supplied the structural engineering design for the UNESCO building in Paris. Since 1932 he has been co-director of the firm of Nervi and Bartoli in Rome, and since 1947 he has been professor of structural design at the University of Rome. While at M.I.T. he will give a public lecture in Italian, which will be translated by Professor Mario Salvadori of the Department of Civil Engineering at Columbia University.

Professor Markelius, who is 72, built the Swedish Pavilion for the New York World's Fair and served as a consultant in the design of the United Nations building. He is especially noted for his work as a city planner, having been director of the central planning office of the City of Stockholm while the city and its suburbs were being developed in ways that attracted world-wide attention. Professor Markelius will be at the Institute for two months and will work with a small group of graduate students on plans for a theater suitable for both traditional and new kinds of stagecraft.

Exhibit Planner

ONE of the attractions of Centennial Week at M.I.T. in April will be an architectural exhibit sponsored by the Department of Architecture and City Planning.

Professor Carl W. Condit of Northwestern University has helped with this project. Professor Condit is the author of *The Rise of the American Skyscraper* and *American Building Art in the 19th Century*.

(Concluded on page 46)

ENGINEERS METALLURGISTS PHYSICISTS

Transitron's growth — Transitron's accomplishments in the electronic industry — are now known throughout the entire nation and Europe.

New plants have been needed to accommodate Transitron's rapid growth. New people — experienced engineers, metallurgists, physicists — are now needed by Transitron. And recent graduates who want a solid future in electronics within a strong, expanding firm, will find just that at Transitron.

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Individuals Noteworthy

(Concluded from page 45)

Psychology Professor

THE M.I.T. psychology program (see page 27, is headed by Professor Hans-Lukas Teuber, an eminent student of the brain and behavior who since 1948 has been head of the Psychophysiological Laboratory at the New York University-Bellevue Medical Center.

Born in Berlin in 1916, Professor Teuber was educated at the French College there and the University of Basel. He received his doctorate from Harvard and was formerly a research psychologist for the Cabot Foundation in Cambridge. His research has dealt with social psychology, perception, and the neural bases of behavior.

He is chairman of the Advisory Committee on Psychophysiology for the Office of the Surgeon General, Department of the Army; and a member of the Mental Health Study Section of the National Institutes of Health and, the International Brain Research Organization of the World Health Organization.

GUESTS of President Lee DuBridge of Caltech at the recent dedication of a new 12,000,000-volt tandem accelerator included (in the usual order) Rear Admiral Rawson Bennett, 2d, James R. Killian, Jr., '26, of M.I.T., and Alfred P. Sloan, Jr., '95, President of the Sloan Foundation.

This new construction prevents water passage through the LENGTH of the cable. Even though accidentally severed, the new DSS-3 cable will withstand 1,000 psi on the exposed end. This unique construction reduces the possibility of flooded compartments or damage to instruments or critical mechanisms by water flowing through the cable due to high pressure.

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HYDROPHONE CABLES — neoprene jacketed, polyethylene coaxials

TV CAMERA CABLES — pressure resistant, with or without strength members

WATER TIGHT COAXIAL CABLES

FATHOMETER CABLES — shielded, 2 conductors

ARMORED FLOATING TOW CABLE — one inch O. D. cable containing 15 conductors and 3 coaxes.

BIW has had long experience in the design and manufacture of special cables to meet unusual underwater applications. We will be happy to send complete information on the work we have done. Our engineers will be glad to work with you toward the solution of your problems.

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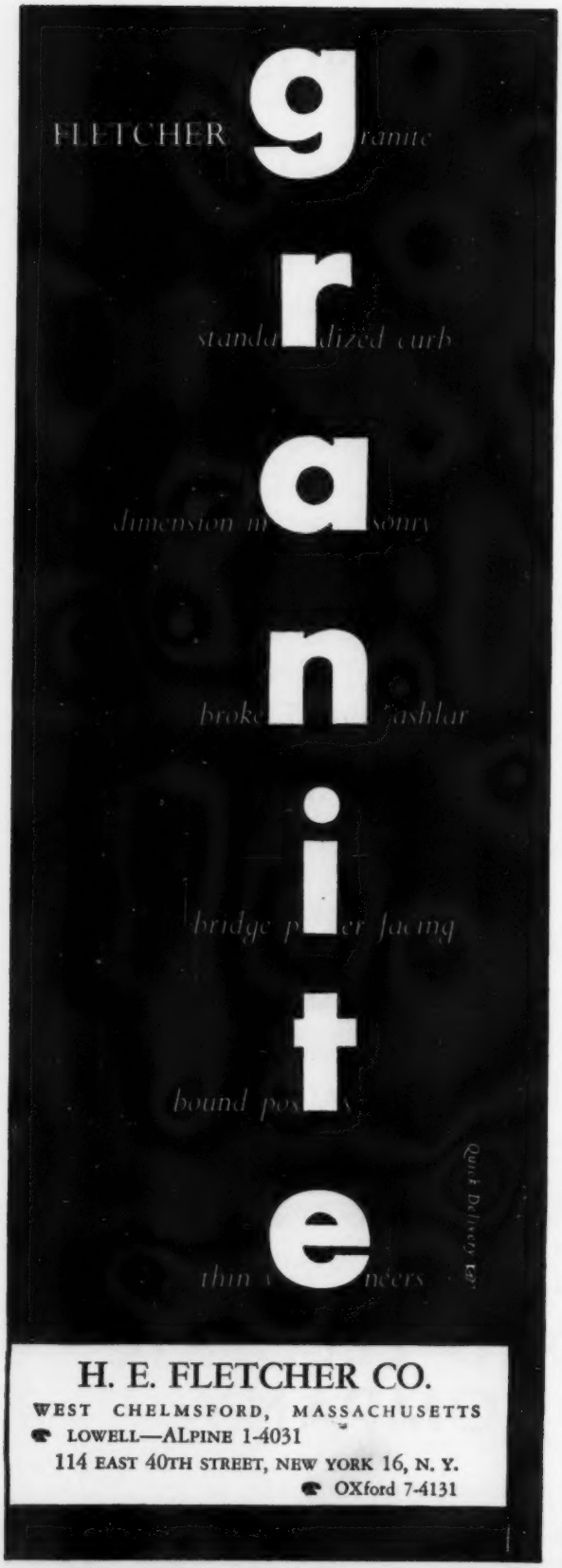

Books

(Concluded from page 26)

THE UPS AND DOWNS OF COMMON STOCKS, by George A. Cowee, '11; Vantage Press ($3). *Reviewed by Donald H. Hensick, '61 Sloan Fellow at M.I.T.*

IF YOU are one of those who knows something about the stock market but doesn't classify himself as expert, here is a volume that you may enjoy. Mr. Cowee's "average" investor has not yet formulated his own investment philosophy, but neither is he a novice in the area.

In a series of 31 short chapters—some less than a page—the author puts you down in the middle of Wall Street and runs you through a short course in finance and market manipulation calculated to broaden your base and lead you in the direction of the wary investor. In this effort he succeeds, admirably. You may not agree with Mr. Cowee in the direction he would lead you; you may shake your head at some of his maxims; you may disagree with some of his economics; but unquestionably you will agree that if you were able to follow his advice to the letter, you would no doubt be a successful investor.

Ups and Downs is almost equally divided between a series of rudimentary chapters on what Wall Street is, investment versus speculation, and some more advanced commentary on investment companies and factors affecting the market such as cycles, ratios, and demand and supply leverage. In the final chapter the author gives you a glimpse of the next major bear market, and what to do to avoid it is developed in the final pages of "Maxims for the Investor." In these latter pages you may find the key to Mr. Cowee's advice which he sums up in a series of definite rules culminating in the thought that successful investing requires infinite patience.

Ups and Downs will prove thought provoking to many, overly cautious to some, and possibly a bit irritating to a few. If you read it and find it in the latter vein you can always give it to your wife who you know would agree with its cautious approach to investing.

Technical Books

NEW, specialized books likely to be of especial interest to M.I.T. Alumni include:

The Federal Government and Higher Education (The American Assembly, Columbia University), contains a section on "Federal Sponsorship of University Research," by Vice-president James McCormack, '37, and Vincent A. Fulmer, '53, of M.I.T. (Prentice-Hall, Inc., $1.95).

Lectures on Communication System Theory, edited by Elie J. Baghdady, '54, of the M.I.T. Department of Electrical Engineering, contains contributions by Donald G. Brennan, '55, Wilbur B. Davenport, Jr., '43, Peter Elias, '44, Robert M. Fano, '41, Paul E. Green, Jr., '53. Thomas Kailath, '59, Robert H. Kingston, '47, Robert M. Lerner, '59, Walter E. Morrow, Jr., '49, Robert P. Rafuse, '57, William L. Root, '43, William M. Siebert, '46, and John M. Wozencraft, '51 (McGraw-Hill Book Company, $12.50).

From New York Life's yearbook of successful insurance career men!

GUY LUCIANO—an avid sports fan, has coached himself to "stardom" selling insurance!

If anything interests Guy Luciano more than sports, it is "meeting and talking to people." Guy manages to do both admirably. In his spare time he coaches semi-pro baseball and basketball teams. On the job, as a New York Life Agent, he meets hundreds of people—and with notable results.

During the last three years, Guy has qualified for the Company's "Star Club," a select group of leading agents. In the last two years, he has sold over a million dollars worth of life insurance protection. Says he: "Insurance selling is the business for anyone who likes meeting people and a good income!"

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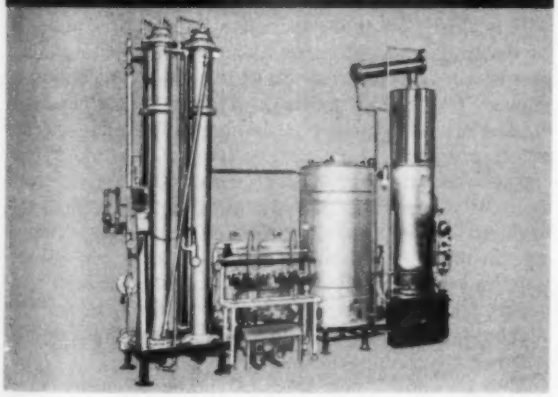

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Psychology's New Status at M.I.T.

(Concluded from page 28)

psychology's first "engineering" achievement—the assessment of the I.Q.

William James at Harvard speculated daringly and searchingly on the complex problems of perception and thought. And in Vienna, Sigmund Freud collected a kind of data that no one ever had collected before—for nearly 40 years, nine or ten hours a day, he listened to people who were trying to tell him everything that passed through their minds, however embarrassing or ignoble or infantile it might be.

These multiple origins in physiology, philosophy, medicine, and education marked out for psychology a vast area of inquiry.

A Sign of Maturity

Today psychology is, after physics, the second most rapidly growing science in the United States. Both the National Science Foundation and the National Institute of Mental Health support psychological research.

The world's need for a science of behavior is so great that this alone might account for the increasing number of able students and quantities of research money. In fact, however, there is a little more than this need: The line of cumulative knowledge about behavior has begun, very slowly, to move. If this movement still is glacierlike in its imperceptibility over short time spans, it is probably also glacierlike in its inevitability.

One sign of maturity is that psychologists today are less concerned about whether they are or are not "scientists"; they are intent on solving problems. Science, after all, is what Wittgenstein called a family concept; the various sciences resemble one another in this or that feature, but it is difficult to find any feature common to them all. They do not all rely on experiments, they do not all use mathematics, and they do not all have a structure of deductive theory.

It is clear now that psychology in one or another of its divisions will resemble most existent sciences and that it will in some respects expand the conception of science. For certain topics, sophisticated mathematical models are now used; e.g., in signal detection and decision processes. For certain topics, the rule-of-one-variable experimental design is possible; e.g., in treatment of psychosis with drugs. For certain topics, naturalistic observation has yielded interesting results; e.g., in the study of animal behavior in its natural setting, and in the study of the development of logic, language, and concepts of number in children. In teaching psychology at M.I.T. we never raise the question whether psychology is or can be a science.

The pressing social need for psychology sometimes has harassed its serious students. Its research findings and theories are social forces as well as knowledge. Unquestionably, much premature psychological advice has been given about raising children, keeping employees contented, and maintaining peace of mind. The serious student of personality is demeaned by faddish vulgarizations of Freudianism and extravagant, unfounded claims for psychotherapy.

At M.I.T. psychology should be able to maintain the standards of evidence that prevail throughout the Institute and, at the same time, encourage the intellectual audacity that a young study needs.

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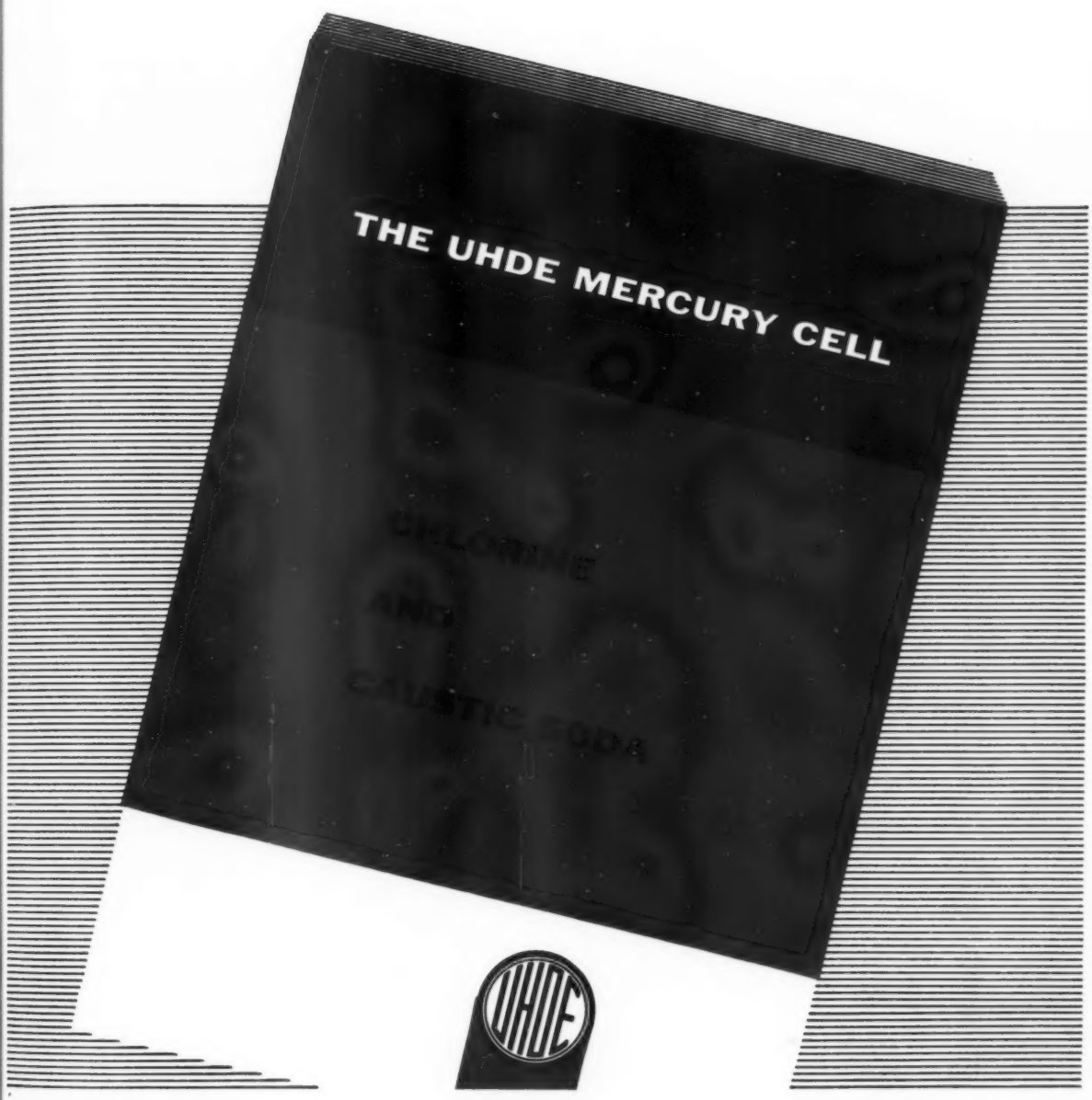

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